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A STUDY TO IDENTIFY OPPORTUNITIES FOR
INCREASED SOLID WASTE UTILIZATION.
VOLUMES VIII AND IX.

Battelle Columbus Laboratories

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16. Abstracts This study concerns the development of greater solid waste utilization through analysis of the secondary materials industry, its sources of supply, its consuming markets, and its economic and technological problems. Eight separate materials and a general report are included. The materials examined are aluminum, copper, lead, zinc, nickel and stainless steel, precious metals, paper, and textiles. Problems inhibiting increased recycling of these materials are identified, and recommended actions are proposed. A survey of the secondary materials industry was the basis for many of the identified problems and also provided numerous statistics on the scrap industry. <i>The report contains Volumes 8 and 9 which deal with paper and textile recycling.</i>		14.	
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As an aid to the reader, the U.S. Environmental Protection Agency has included the master bibliography for the entire nine-volume work at the back of this book.

A STUDY TO IDENTIFY OPPORTUNITIES
FOR INCREASED SOLID WASTE UTILIZATION

Volume VIII: Paper Report
Volume IX: Textile Report

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1972

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N O T I C E

This report is part of a series of 9 volumes on the recycling of solid waste materials:

<u>Volume</u>	<u>Materials Covered</u>
I	General Report
II	Aluminum
III	Copper
IV	Lead
V	Zinc
VI	Nickel and Stainless Steel
VII	Precious Metals
VIII	Paper
IX	Textiles

The reader should read Volume I as well as the volumes covering materials of specific interest. Volume I provides a brief summary of the other 8 volumes, plus an analysis of activities and recycling problems common to all of the commodities. Areas of commonality include such matters as legislation and its effect on recycling, and a description of the equipment used in processing secondary materials. It also presents a statistical profile of that portion of the secondary materials industry studied.

VOLUME VIII
PAPER REPORT

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SUMMARY

In 1969, approximately 58.2 million tons of paper and paperboard were consumed in the United States. Of this consumption, approximately 30 million tons was in the form of paper, 23.5 million tons in paperboard, and 4.6 million tons in the form of construction paper and board. Newsprint accounted for approximately 9.8 million tons of paper consumed, approximately 6.8 million tons of which was imported.

Of the 58.2 million tons of paper and paperboard consumed in the United States in 1969, approximately 11.4 million tons or 19 percent was recycled. The balance of 46.8 million tons, which represents 81 percent of the total, was not recycled. Important problems related to the quantitative aspects of paper recycling are summarized in Table I.

Changing Aspects of the Paperstock Industry

Over the period of time during 1970 and 1971 when the research upon which this report is based was conducted, many changes have occurred that have affected the paperstock industry. The major impetus for these changes has been the growing awareness of the magnitude and serious nature of the solid waste problem and the realization by society of the important role the paperstock industry has played in the past and can play in the future to minimize solid waste accumulation.

Up until quite recently, almost all discussions of paperstock and the paperstock industry tended to deal with the volume of paper being recycled. Little note was made of the great volume of paper and paperboard not recycled that has moved into solid waste channels.

TABLE I. IDENTIFICATION OF QUANTITATIVE PROBLEMS OF PAPER RECYCLING, 1969

Title	Total U. S. Consumption of Paper and Paperboard	Permanent or Semi-Permanent End Use Categories
PROBLEM DEFINITION	As annual consumption of paper and paperboard increases and the percentage of material recycled decreases, the quantity of waste-paper falling into solid waste channels increases significantly	These categories generally are not considered to be economically recoverable because of difficulties of collection and/or separation.
THOUSANDS OF TONS CONSUMED AND POTENTIALLY AVAILABLE FOR RECYCLING (a)	58,200	10,000 ^(b)
THOUSANDS OF TONS RECYCLED ^(a)	11,400	--
THOUSANDS OF TONS NOT RECYCLED ^(a)	46,800	10,000 ^(b)
% NOT RECYCLED ^(a)	81	100 ^(b)
PROBLEM BACKGROUND	1. Average annual per capital consumption is about 575 pounds per person. 2. Consumption is growing at an annual rate of about 4.5 percent. 3. 12,000 kinds of paper and paperboard are utilized in more than 100,000 end uses. 4. Major product groupings based on end use are communications papers, packaging papers and boards, construction and industrial papers and boards, and sanitary and personal use papers. 5. Percentage of recycled paper has declined from 26% in 1959 to 19% in 1969. 6. NASMI (PSIA) and EPA are focusing public attention on the need for (a) increased recycling as a means of reducing future solid waste problems and conserving natural resources and (b) increased purchasing of recycled fiber products.	1. Some grades are permanent or semi-permanent end use products in themselves. 2. Others are incorporated into products having long-term use. 3. Categories include: papers for permanent records and publications, construction paper and board, and papers in electronics automotive, and other manufactured end uses. 4. This is not a promising area in which to increase recycling of paper.

SOURCES: (a) The Statistics of Paper, 1970 Supplement, American Paper Institute, p. 24, 26.

(b) Pulp, Paper, and Board; BDSA Quarterly Industry Report; U. S. Dept. of Commerce; October, 1970; p. 8-10.

xvi-a

TABLE I. IDENTIFICATION OF QUANTITATIVE PROBLEMS OF
PAPER RECYCLING, 1969 (Continued)

Title	Newspapers	Containerboard
PROBLEM DEFINITION	Fluctuating and relatively declining demand for combination paperboard and high transportation costs (resulting from distances from adequate sources to markets) limit recycling of old news.	Fluctuating and relatively declining demand for combination paperboard and high transportation costs limit recycling of containerboard.
THOUSANDS OF TONS CONSUMED AND POTENTIALLY AVAILABLE FOR RECYCLING (a)	9,800	15,900
THOUSANDS OF TONS RECYCLED ^(a)	2,400	3,900
THOUSANDS OF TONS NOT RECYCLED ^(a)	7,400	12,000
% NOT RECYCLED ^(a)	76	76
PROBLEM BACKGROUND	1. These become available as wastepapers in households, institutions, newspaper plants, retail dealers and distributors. 2. Substantial amounts of old news are collected by charitable agencies. 3. Some communities are calling on residents to segregate old news collected. 4. Relatively greater amounts of old news were recycled during World War II because of shortages of virgin pulp and patriotic motivation of consumers to save and turn in old newspapers. 5. Old news is used principally in production of combination paperboard, for which demand has been declining relative to solid paperboards. 6. De-inking of old newspaper for use, in production of de-inked news is a relatively new and growing end use.	1. This is the single paper and paperboard product produced in largest volume. 2. Consists of linerboard and medium and is converted into packaging and shipping containers. 3. Very little ends up as waste in the residential sector. 4. Major amounts recycled are recovered from converting plants and wholesale and retail establishments. 5. Along with old news, old corrugated containerboard is used principally in production of combination paperboard, but increasing quantities of old corrugated are moving into production of new containerboard.

TABLE I. IDENTIFICATION OF QUANTITATIVE PROBLEMS OF
PAPER RECYCLING, 1969 (Continued)

Title	Pulp Substitutes and Mixed Papers
PROBLEM DEFINITION	Under present conditions, demand and supply are approximately in balance for pulp substitutes, which are fairly homogeneous clippings and other wastes from printers and converters. Mixed papers include thousands of different grades of paper and paperboard in various states of contamination by inks, coatings, laminations, etc., and therefore are difficult to recycle.
THOUSANDS OF TONS CONSUMED AND POTENTIALLY AVAILABLE FOR RECYCLING (a)	22,500
THOUSANDS OF TONS RECYCLED ^(a)	5,100
THOUSANDS OF TONS NOT RECYCLED ^(a)	17,400
% <u>NOT</u> RECYCLED ^(a)	77
PROBLEM BACKGROUND	1. Mixed papers originate as wastes in offices, plants, retailers, wholesalers, institutions, and households. 2. If demand for end products made from secondary fibers increases, segregation or sorting of mixed papers into marketable grades will be encouraged. 3. Toilet tissue consumed, which represents 1.3 million tons per year, is not recoverable.

With the growing awareness of the solid waste problem and the role which the paperstock industry could play in alleviating the problem, the paperstock industry has acquired a new identity and new image. Dealers and users have received inquiries from environmentally concerned members of society as to how the public can assist the paperstock industry in minimizing solid waste accumulation. The industry response has been that the most constructive action which consumers can take is to specify products made from secondary fibers. Recognizing that the combination paperboard industry has traditionally been the major user of paperstock, the paperstock industry has urged that consumers demand that the products they purchase be packaged in containers made from combination paperboard.

In response to the urgings of various organizations interested in environmental quality, buyers of paper and paperboard products in government and industry have started to shed their bias toward materials made from secondary fibers. These biases, in many cases, have been manifested in the form of purchasing specifications that have limited the markets for products made from secondary fibers.

As a result of the collective efforts of EPA, CEQ, and the paperstock industry, specification changes have been initiated by some government agencies and other organizations. The City of New York recently advised that it would be purchasing various grades of office paper made from reclaimed fibers. One of the larger banking institutions in New York City began the utilization of paper made from recycled fiber, and the paperstock industry, early in February of 1971, anticipated that other corporations would follow this lead in the near future.*

* Stovroff, H., address presented at the Wastepaper Work Shop held during Recycling Day, New York, New York (February, 1971).

The Federal government has also taken a new look at its paper purchasing practices. Early in 1971, President Richard M. Nixon announced in his Environmental Message that the General Services Administration (GSA) had revised 14 specifications for paper products amounting to approximately one third of the total purchases of "supply paper" by GSA. The other 12 specifications were under review at the time.*

The Generation, Flow, and Use of
Wastepaper and Paperstock

Origins or Sources of Wastepaper

In a strict sense, paper and paperboard products, like any number of other products are not really "consumed". First they are produced, and in the process of this production or conversion, wastes are generated. Next they are "used" and eventually discarded and become wastes, which unless they are diverted, move into solid waste channels. It is this process of diversion, through recycling, which is the prime function of the paperstock industry and a deterrent to the excess accumulation of solid wastes.

* Brown, G., "The Federal Government and Recycling", American Paper Industry, April, 1971.

There are five major families of paperstock grades based on classifications established by the Bureau of Census and other agencies. These grades are: mixed papers, news, corrugated, high grade pulp substitutes, and high grade de-inking grades. Paperstock, by definition differs from wastepaper in that paperstock is wastepaper which has been collected, sorted, and graded to meet the specifications of consuming industries.

Some 9 different broad categories or sectors of paper and paperboard "consumers" generate wastepaper. The sectors include: the residential or household sector, the institutional sector, office buildings, the retail sector, the wholesale sector, the transportation sector, the printing and converting sector, the service industry sector, and other industrial and commercial sectors. Mixed papers are generated in all sectors as are substantial quantities of newsprint. Relatively small quantities of corrugated shipping containers reach the residential or household sector. The bulk of old corrugated and similar shipping containers go no further than the retail, wholesale and other industrial and commercial sectors and thereafter are discarded by these generators. The more homogenous forms of wastepaper or those which can be most readily sorted into more uniform, and therefore, higher grades of paperstock, are generated principally in the printing and converting sector. These relatively homogenous high grades are principally in the form of cuttings or trimmings resulting from the printing and conversion processes and never reach "consumers" in the form of finished products as do other forms of wastepaper.

Collection, Processing, and Distribution

Waste paper and paperstock move from generators to users through two basic channels. In following one channel, waste paper travels from generator to dealer or processor (who segregates the waste paper into various forms of paperstock); then the paperstock is moved from the dealer or processor to the user. The other basic channel involves movement of processed waste paper (paperstock) from the generator directly to the user.

The movement of wastepaper from the residential sector to dealers or processors is complicated by the fact that except for old newspapers, most wastepaper generated in the residential sector is completely lacking in homogeneity and can only, at best, be classified as highly contaminated mixed paper. Accordingly, this wastepaper generated in the residential sector is lowest in value and, under present technology, least economic to recycle. Yet, the quantities thus generated are substantial and represent, perhaps, the greatest challenge of all in the effort to minimize solid waste accumulation. Old newspapers generated in residences are collected and moved to processors, principally through the efforts of charitable groups, and then are recycled; but there are significant differences in regional demand for this form of wastepaper.

The movement of wastepaper from the industrial/commercial sector to dealers and processors is complicated, particularly in metropolitan areas, by the urgency of moving wastes quickly from generators' establishments. Business firms recognize that waste materials, when stored on the premises, consume valuable space which could be more productively devoted to profitable activity.

Further, these wastes create hazards and tend to detract from the appearance of an establishment. Some industrial/commercial generators, depending upon the nature of their activities and their resulting wastes, do some preliminary segregating or sorting and baling of wastepaper, both in order to enhance its value in the marketplace and to minimize the costs of temporary storage of this material.

It is difficult to make even broad generalizations about details of the route for paperstock from dealers/processors to users. Patterns differ widely depending upon the geographic areas considered, the grades of paperstock, and the relationships between dealers and their customers. By comparison with other commodities, paperstock is generally low in value with respect to its weight and bulk. Thus, it has been uneconomic to move the low value grades long distances to points of potential use. Unfortunately, it has been the accumulation of these low value, bulk grades of paperstock which represents a major challenge in the efforts to minimize flows of wastes into solid waste channels. Exportation of wastepaper, while increasing in response to demand from fiber-poor foreign countries has, for the most part, been constrained by the high costs of overseas shipment.

Substantial quantities of paperstock are moved directly from points of generation to points of use. When such arrangements are made, to a large degree by brokers and dealers, the vital functions of sorting and grading still cannot be bypassed. Instead, these functions become the responsibility of the generators, or in part, that of the paperstock users.

Handling and processing of wastepaper consists of changing the character of wastepaper to make it a marketable commodity in the form of paperstock,

wherever these functions are performed. Segregating wastepaper, clearly restricted to the generator level, differs from sorting in that segregating involves keeping different types of wastepaper separate, initially, before they become mixed together, while sorting calls for separating the types after they have already been mixed together. Sorting may occur at either the generator, processor, or user level. Shredding, hogging, and baling as these operations may be practiced at the generator and processor levels are also considered to be handling and processing functions.

Uses and Markets

Paperstock's percentage of total fibrous materials consumed in making paper and paperboard has steadily declined from 26.4 percent in 1959 to 19.0 percent in 1969.

In 1969, 70.5 percent of all paperstock was consumed by the paperboard industry, 17.5 percent in the production of construction paper and board including wallboard, and 12.0 percent in the production of newsprint and other paper. Although recent figures are unavailable as to the percentages of paperstock consumed in the production of individual grades of paper and paperboard, it is known that most of the paperstock used by the paperboard industry is consumed in the production of so-called "combination" paperboard which, by definition, contains less than 15 percent of virgin wood pulp. About 28 percent or 7.3 million tons of paperboard produced in 1969 was classified as boxboard type, used principally in the manufacture of folding cartons. Less than 15 percent of the total of about 17.8 million tons of containerboard, used principally in the production of corrugated and solid fiber shipping containers, is classified as combination type containerboard.

The paper industry, by comparison with the paperboard industry, is a far smaller consumer of paperstock. As has already been noted, only about 12 percent of total paperstock consumed in 1969 was consumed in the production of papers other than construction papers. Except for the old news consumed by newsprint de-inking mills and the mixed or other grades consumed by construction paper mills, all of the paperstock consumed in the paper subdivision is either high-grade de-inking paperstock or high-grade pulp substitutes. These grades are consumed by mills producing sanitary and tissue paper, printing papers, book papers, and fine papers. Although accurate or timely quantitative data on consumption of paperstock in the production of other products is not available, additional end uses do exist. Among these other products in which paperstock is used as raw material are molded egg cartons, flower pots, funeral wreath holders, soil pipe, and insulation materials. Significantly, it is known that most of the paperstock consumed in the production of these products is in the form of low grades or bulk grades of mixed papers, news, and old corrugated, which as has been noted, contribute to the solid waste problem. The relatively high cost of virgin wood pulp makes its use prohibitive in the production of most of these products or materials.

Recommendations

The recommendations resulting from this study are in the form of suggested actions which might be taken by the paperstock industry, by EPA, by consuming industries and by others with relevant interest, in response to six "families" of qualitative problems currently constraining recycling of paper. These problem families are defined and analyzed in Table II following.

TABLE II. IDENTIFICATION AND ANALYSIS OF QUALITATIVE PROBLEMS AFFECTING RECYCLING

Problem Area	Relatively Declining Demand for Products Made from Paperstock	Erratic Demand for Paperstock	Lack of New Products Made from Paperstock
Problem Definition	1. Demand for combination paperboard cartons has not increased at the rate of that for cartons of virgin fiber, therefore, virgin fiber paperboard producers have gained an increasing share of the market. 2. Some knowledgeable users and research groups consider virgin fibers to be superior to secondary fibers in certain high volume end uses, especially where high strength is required. 3. Packaging buyers sometimes choose to overpackage (use virgin fiber containers where secondary fiber containers would suffice) to enhance the marketability of their products.	1. Paperstock demand fluctuates as demand for paper, board, and/or converted products fluctuates. Some seasonality because of mill shutdowns in summer. 2. Mills are reluctant to carry extensive paperstock inventories. 3. Paperstock is perishable and hazardous to handle and store. 4. Space for storage of paperstock is both limited and costly. 5. Some collectors go out of business when demand is low.	1. Many authorities in the paperstock industry feel that successful development of new products made from paperstock is the "major factor" that will materially increase recycling. 2. Oversupplies of bulk grades of paperstock add to the solid waste problem. 3. The only significant new use for paperstock developed in the past decade has been as raw material for newsprint de-inking mills of Garden State Paper Company.
Effect on Recycle Rate	Major constraining effect on recycling of paper.	Major impact on paperstock industry and, hence, on recycling of paper.	Development of new uses for paperstock necessarily will increase recycling.
Remedial Actions Considered	1. Improve techniques for making paper, board, and converted products from paperstock to be more competitive with those made from virgin fibers. 2. Develop strategies to increase acceptance of these products. 3. Develop educational programs to offset the stigma associated with recycled materials. 4. Determine the economic impact and various other impacts of legislation to restrict use of virgin fibers. 5. Provide incentives to invest in new capacity to use secondary fibers or resume use of idle capacity. 6. Encourage the government and others to specify products made from recycled paper.	1. Improve methods of compacting and hogging paperstock so as to conserve storage space. 2. Investigate techniques for pelletizing wastepaper or paperstock. 3. Encourage negotiation of longer term contracts for paperstock. 4. Provide incentives for increased warehousing by processors and users. 5. Encourage the government to stockpile paperstock.	1. Investigate the possibility of combining bulk wastepaper with waste textiles to result in new materials and to solve two environmental problems simultaneously. 2. Investigate the possibility of combining waste paper with lignins or tall oil to result in new materials. 3. Investigate alternative methods of separation of paper fibers in waste paper. 4. Ideas for possible new products should be first screened as to market feasibility (size and character of market, etc.) before extensive technical research is performed.

TABLE II. IDENTIFICATION AND ANALYSIS OF QUALITATIVE PROBLEMS AFFECTING RECYCLING
(Continued)

Problem Area	Increasing Contaminants	High Costs of Transportation
Problem Definition	1. Development and introduction of new coatings, laminations, adhesives, etc., over the past two or three decades have increased contamination of waste paper generated. 2. High costs of sorting and the dependence on hand labor make the proliferation of contaminants a major factor constraining recycling. 3. Most generators are unfamiliar with the needs of markets for paperstock and the problems created by contaminants. 4. Most generators are not interested in the waste business and have not been motivated to cooperate with the paperstock industry. 5. Users of paperstock often impose extraordinary demands on suppliers or question reliability of supplies and suppliers.	1. Costs of transporting wastepaper represent a high percentage of total costs because wastepaper has low value relative to its bulk and weight. 2. Waste paper sources often are concentrated in geographic areas distant from users, resulting in high shipping costs. 3. Variations in local supply/demand situations make it difficult to establish broad national policies. 4. "Red tape" tends to restrict exporting of paperstock.
Effect on Recycle Rate	Major constraining effects on recycling of paper.	Major impact on paperstock industry and, hence, on recycling of paper.
Remedial Actions Considered	1. Develop inks, coatings, adhesives, etc., which do not inhibit recycling for use in printing and conversion. 2. Improve techniques for segregating wastepaper at the generator level. 3. Improve techniques for sorting at all levels. 4. Improve methods for cleaning and de-inking at the user level. 5. Consider legislation to penalize producers or users of contaminating materials.	1. Develop more economical means of transporting wastepaper and paperstock over both short and long distances. 2. Consider establishment of freight rates more favorable to shippers of wastepaper and paperstock. 3. Consider subsidies to dealers or processors to offset the high costs of overseas shipments now restricting exporting. 4. Consider feasibility of producing "market pulp" from paperstock.

TABLE II. IDENTIFICATION AND ANALYSIS OF QUALITATIVE PROBLEMS AFFECTING RECYCLING
(Continued)

Problem Area	Operational Problems
Problem Definition	1. At wage rates usually offered for processing wastepaper, labor is either undependable or unavailable in many areas where paperstock is generated or processed. 2. By certain standards, some environmental pollution results from use of paperstock for making paper. 3. There is a need for more and better economic analyses to support arguments for using paperstock instead of virgin fibers. 4. The paperstock industry has suffered from a poor image. 5. Many paperstock organizations are relatively small. 6. Dealers' trucks often are tied up at locations of generators and users for excessive time periods. 7. Baling equipment is costly and occupies costly space. 8. Users often consider risks in using paperstock to be relatively high because of the limited liability of dealers. 9. Growing competition for the efforts of charitable agencies that collect wastepaper may add to collection costs. 10. Changing philosophies in customer organizations tend to limit the flexibility of dealers in negotiations. 11. Financial community generators of wastepaper and some government agencies must retain the material temporarily. 12. Management decisions to dispose of wastes by incineration are often difficult to reverse.
Effect on Recycle Rate	Major constraining effects on recycling of paper.
Remedial Actions Considered	1. Develop incentives to attract more and better labor and management level personnel. 2. Develop improved cleaning processes and/or markets for wastes generated in the process of cleaning paperstock by users. 3. Compile accurate figures on comparative costs of using virgin versus secondary fibers. 4. Consider the possibility of multiple mergers of relatively small dealer/processor organizations into fewer large firms which are likely to have greater bargaining power and greater overall capabilities. 5. Consider initiation of industrial engineering studies aimed at optimizing the handling and processing of wastepaper and paperstock.

Table III following shows the rating of the qualitative problem families against pre-determined criteria in order to arrive at a sequence of priorities. Finally, Tables IV and V state the high and low priority action recommendations suggested in response to the three high priority and the three low priority families of problems.

The relatively declining demand for products made from paperstock is seen as the highest priority individual problem constraining paper recycling today. Activities recommended to arrest or reverse this trend consist of (1) technical research to improve the character of products made from paperstock, (2) development of strategies and educational programs to counteract prejudices against products made from all classes of secondary materials; and (3) the encouragement of government and other influential purchasers to amend specifications which have made it impossible for marketers of recycled paper products to sell their products to these agencies or companies. Some of these recommended activities, of course, have already been initiated by companies and trade associations concerned with the paperstock industry. It is recommended, however, that further support from EPA be solicited at least in connection with the technical research activities suggested.

The erratic demand for paperstock is identified as representative of the second highest priority family of problems constraining recycling. It is noted that the demand for paperstock would be extremely difficult to stabilize effectively, but some activities recommended may serve to minimize the effects of fluctuations in demand for paperstock. These activities include development of improved technologies for compacting, hogging, shredding, or pelletizing paperstock to improve the economics of warehousing this commodity. Again, EPA support to manufacturers of equipment in undertaking these activities might be solicited.

TABLE III. EVALUATION OF GENERAL PROBLEMS RELATED TO RECYCLING OF PAPER

Problem	Criteria and Scores				Total Score (20)
	Solution of Problem Will Improve Environment (10)	Solution of Problem Will Conserve Natural Resources (5)	Realistic Solution Can Be Found (5)		
(Maximum Possible Score)					
Relatively declining demand for products made from paperstock	10	5	5		20
Erratic demand for paperstock	10	3	4		17
Lack of new products made from paperstock	10	3	2		15
Increasing contaminants	9	3	1		13
High costs of transportation	6	2	4		12
Operational problems	5	4	1		10

Source: Judgements of Battelle project team with concurrence of NASMI Commodity Committee, April, 1971.

TABLE IV. HIGH PRIORITY PAPER RECYCLING PROBLEMS AND RECOMMENDED ACTIONS

Problem Area	Relatively Declining Demand for Products Made from Paperstock	Erratic Demand for Paperstock
Action Recommendations	1. Conduct technical research to improve paper, paperboard, and converted products made from paperstock and/or reduce costs. 2. Develop strategies and educational programs to increase acceptance of and remove stigma from products made of paperstock. 3. Push for nondiscriminatory purchase specifications from government agencies and others.	1. Improve methods of compacting, hogging, and pelletizing waste paper and paperstock. 2. Encourage negotiation of longer term contracts for purchase of paperstock.
Recommended Participants in Above Actions ^(a)	1. EPA, PSIA, paper and paperboard producers, API, BRDA, IPC and TAPPI. 2. PSIA and paper and paperboard producers using recycled fibers. 3. NASMI	1. EPA and equipment manufacturers 2. Paperstock dealers and PSIA.
Comments on Other Actions Considered	Efforts to get through legislation providing incentives for combination board producers or tending to restrict use of virgin fibers can be expected to be a controversial matter and therefore early favorable effects can not be determined at this time.	Economic incentive programs to increase warehousing of paperstock by processors and users may prove to be too difficult to administer. Lack of homogeneity of paperstock and difficulty in grading uniformly would tend to make the administration of stockpiling by government quite difficult.

- (a) It is suggested that NASMI continue its leading role in recycling, recognizing that other organizations such as Department of Commerce, Council of Environmental Quality, HEW Office of Information, and State, Local, and Federal Legislatures must also be involved.

TABLE IV. HIGH PRIORITY PAPER RECYCLING PROBLEMS AND RECOMMENDED ACTIONS
(Continued)

Problem Area	Lack of New Products Made from Paperstock
Action Recommendations	1. Conduct technical and economic research as to feasibility of combining waste paper with textile wastes and other materials to produce new materials or end products. 2. Conduct idea generation session to identify new product possibilities, and screen ideas generated with regard to market opportunities, etc.
Recommended Participants in Above Actions ^(a)	1. EPA, PSIA, API, chemical, textile and other product producers, and contract research organizations. 2. EPA and contract research organizations.
Comments on Other Actions Considered	Investigation of alternative methods of separating paper fibers in paperstock has been a continuing challenge for paper and paperboard producers and their representatives on TAPPI committees.

TABLE V. LOWER PRIORITY PAPER RECYCLING PROBLEMS AND RECOMMENDED ACTIONS

Problem Area	Increasing Contaminants	High Costs of Transportation
Action Recommendations	1. Develop inks, coatings, adhesives, etc., which do not inhibit recycling for use in printing and conversion of paper and paperboard. 2. Improve techniques for segregation and sorting of waste paper and paperstock at all appropriate levels. 3. Develop improved methods of cleaning and de-inking and/or coping with contaminants at the user level.	1. Encourage establishment of freight rates favorable to expansion of recycling of waste-paper and paperstock. 2. Push for economic incentives to dealers or processors to increase recycling by offsetting the high costs of overseas shipments now restricting exporting. 3. Investigate technical and economic feasibility of producing "market pulp" from paperstock.
Recommended Participants in Above Actions(a)	1. EPA and ink and adhesives manufacturers, etc. 2. EPA, equipment manufacturers and contract research organizations. 3. EPA, PSIA, paper and paperboard producers, API, BRDA and contract research organizations.	1. EPA, NASMI, and paperstock dealers and processors. 2. EPA, NASMI, paperstock dealers and processors. 3. PSIA, EPA, and BRDA.
Comments on Other Actions Considered	Efforts to encourage legislation to penalize producers or users of contaminating materials may be unrewarding. If such legislation were enacted, difficulties in administering and enforcing it would limit its favorable effect on recycling. However, the possibility of such legislation may encourage industry to give priority to other alternatives.	The development of more economical means of transporting waste paper and paperstock may be too large and broad an objective for the paperstock industry alone. Efforts are already being made by others in this general direction.

- (a) It is suggested that NASMI continue its leading role in recycling, recognizing that other organizations such as Department of Commerce, Council of Environmental Quality, HEW Office of Information, and State, Local, and Federal Legislatures must also be involved.

TABLE V. LOWER PRIORITY PAPER RECYCLING PROBLEMS AND RECOMMENDED ACTIONS
(Continued)

Problem Area	Operational Problems
Action Recommendations	1. Develop better cleaning processes and/or conduct programs to identify markets for residual wastes generated in the process of cleaning or deinking paperstock by users; then conduct technical and economic feasibility studies. 2. Assemble reliable bodies of statistical data comparing economics of using secondary fibers and virgin fibers. 3. Conduct industrial engineering studies aimed at optimizing the handling and processing of wastepaper and paperstock.
Recommended Participants in Above Actions(a)	1. PSIA, paper and paperboard producers and contract research organizations. 2. PSIA, combination paperboard producers and other present users of both secondary and virgin fibers. 3. PSIA
Comments on Other Actions Considered	The thought of developing incentives for labor may be too large and broad an objective for the paperstock industry alone. Others in government and other industries are already working on this problem. Their success may prove to be beneficial to the paperstock industry. No actions to attract more management personnel were identified during the study.

The critical need for new products made from paperstock is identified as representative of the third high priority family of problems. Two activities are recommended in response to this problem family. These are to investigate the feasibility of combining paperstock with other materials to form new materials and to conduct idea generation sessions aimed at the identification of potential new products. The idea generation, clearly, must be followed by economic evaluation of the ideas generated before technical research in depth is initiated. The most logical participants in these activities, supported by EPA, are seen to be research organizations working cooperatively with paper and paperstock industry trade associations and with producers of other basic materials.

The problem of increasing contaminants in wastepaper and the effects or symptoms of this problem are seen to constitute the first of the lower priority families of problems constraining recycling. The activities recommended to help solve this problem family consist of development of water soluble materials (inks, adhesives, etc.) which do not constrain recycling, development of improved segregation and sorting techniques, and development of improved cleaning and de-inking techniques to permit users to cope more effectively with contaminants. EPA support for all of these activities might also be solicited. Participants in the activities logically would include ink and adhesive manufacturers, equipment manufacturers, paper and paperboard producers, trade associations and research organizations.

The high cost of transportation is identified as the second lower priority family of problems constraining use of paperstock. The most viable activities which would help to minimize the effects of this general problem are those

pointed toward establishment of freight rates more favorable to shippers of paperstock or toward the issuance of subsidies to paperstock dealers offsetting the high costs of overseas shipment. Investigation of the feasibility of producing "market pulp" from paper stock to reduce transportation costs is also recommended. NASMI and member firms of the PSIA Division seem to be the logical participants in such programs, with support from EPA and others as appropriate.

The last family of problems constraining recycling consists of problems broadly considered to be operational in nature. Operational problems involve such areas as absenteeism and unavailability of labor, environmental pollution resulting from the use of paperstock, lack of adequate data comparing the costs of using virgin versus secondary materials, etc. No solutions are visualized or activities recommended in response to certain of the operational problems identified. In other cases, solutions are anticipated, hopefully, as a result of broadly based activities already undertaken. Changes in welfare programs presently under study, for example, may have a significant effect on the broad problem of absenteeism and unavailability of labor in the paperstock industry as well as other industries.

The most viable activities recommended in answer to operational problems consist of (1) development of better cleaning processes and/or identification and analysis of markets for unavoidable wastes generated in cleaning paperstock, (2) the compilation of accurate figures on comparative costs of using virgin versus secondary fibers, and (3) consideration of industrial engineering studies to optimize handling and processing of waste paper and paperstock. All of these activities, it is felt, seem to be appropriate to PSIA. Research programs could lead to development of improved cleaning processes and assist in the identification and evaluation of markets for residuals, possibly with some direct or indirect support from EPA. On the

other hand, accumulation of data on comparative costs of using virgin versus secondary fibers is an activity which might best be conducted by PSIA with necessary help from members integrated with or closely associated with paper or paperboard producers who have a background of experience in using both secondary and virgin fibers.

INTRODUCTION

In June, 1970, Battelle-Columbus undertook a research program for the National Association of Secondary Material Industries, Inc. (NASMI). This work was carried out under a subcontract from an Office of Solid Waste Management grant to NASMI. This report on paper is one of a series of eight commodity reports plus a general or summary report.

Background

The Office of Solid Waste Management is responsible for formulating and recommending Federal Government policies in the area of solid waste pollution. This includes pursuing appropriate research to determine the status and problems of solid waste activities, and to develop programs to reduce solid waste pollution.

One approach to the reduction of solid waste pollution is to reclaim waste materials for reuse - the recycling concept. A well established industry--the secondary materials industry--exists to accomplish this recycling. NASMI is the trade association representing the nonferrous metals, paper, and textiles portion of this industry.

The scrap processors, secondary smelters, paperstock dealers, and other companies that make up the secondary materials industry have developed effective channels and methods for recycling nearly all waste materials of economic value. These companies have performed their difficult and essential functions well in the traditional economic environment.

More recently additional dimensions have been added to this traditional economic environment. These new dimensions are (1) improvement of the environment in which we live, and (2) increased need for conservation of natural resources. These new dimensions provide new challenges and opportunities for the recycling industry. No longer is economic gain the sole driving force for recycling of waste materials. Social gain has been added in the forms of improved living conditions and preservation of resources for future generations. In an economics-based nation this creates problems of interpretation and evaluation of noneconomics-based goals and activities.

The purpose of this series of reports is to identify obstacles to the recycling of nonferrous solid wastes, and to recommend directions for investigation and research to overcome these obstacles.

Objectives

The objective of the study on which this report is based was to identify opportunities for the increased utilization of solid waste. The major sub-objectives were:

- (1) To determine the structure and functions of the secondary materials industry, and its relationships to sources of supply and markets
- (2) To identify and evaluate problems of recycling - materials, sources, industry, and markets, and
- (3) To determine opportunities for increased recycling.

Scope

The major subjects included in the scope of the study are the secondary materials industry, the materials it recycles, the sources of solid wastes, and the markets for recycled materials. Activities peripheral to these major subjects are considered where pertinent to recycling.

The materials included in the study are:

Aluminum

Nickel and Nickel Alloys

Copper and Copper Alloys

Precious Metals (Silver, Gold and Platinum)

Lead

Paper

Zinc

Textiles

Research Methods

The methods and procedures used in the study are discussed under four types of activities. They include (A) literature search, (B) extensive survey, (C) in-depth survey, and (D) analysis and synthesis.

Literature Search

The literature search included reviewing and studying books, Government reports, industry reports, and trade journals covering solid waste handling and problems, recovery and market data, and recycling of valuable materials.

The results of this effort included the accumulation of data and descriptive material, and an organized bibliography dealing with each of the commodities covered in the scope of the study.

Extensive Survey

The extensive survey of the secondary materials industry consisted of a mail survey and personal interviews with management personnel of companies involved with the collection, processing, and sale of secondary materials. About 600 responses were received.

The information developed through the extensive survey included dollar sales, tons of major materials handled, types of solid waste processed, sources of materials, investment, equipment and facilities, number of employees, the amount of space used, and the grades and quantities of secondary materials produced.

The data from the extensive survey provided statistical tabulations of the regional distribution of the secondary materials industries by type of commodity in terms of numbers of establishments, volume of business, and numbers of employees.

In-depth Survey

The in-depth survey of selected members of the secondary materials industries, their suppliers, and the users of their products served to identify the major technical and economic problems facing those companies involved with secondary material utilization. About 200 interviews were completed. Battelle and NASMI commodity specialists jointly selected the companies to be interviewed in depth.

Interview guides for each of the commodities were prepared. The problems and potential solutions for greatest recycling and waste utilization that were developed from the literature search and prior Office of Solid Waste Management work plus the knowledge of the NASMI commodity specialists provided the basis for designing the interview guide. Sample guides are reproduced in the Appendix of the General Report.

Analysis and Synthesis

The analysis and synthesis step was concerned with the collation and analysis of data and information derived from both the literature, extensive survey, and in-depth survey. The analysis and synthesis activity covered the following tasks:

- (1) Economic Data on the Secondary Materials Industries. The economic data developed through the extensive survey of the secondary materials industries were tabulated and analyzed as to the amount and type of solid waste handled and as to operational data such as number of employees, amount of space required, capitalization, and geographic locations.

- (2) Flow Diagrams and Life Cycles. Flow diagrams were developed to indicate the flow of materials from primary production and scrap sources through fabrication. Life cycle estimates of various products were used to develop data on quantities available for possible recycling.
- (3) Demand-Supply Relationships. Estimates were made of future demand and supply levels for secondary materials. The relationship between these data provide an indication of potential surpluses or shortages of recycled materials through 1980.
- (4) Stability of Flow and Consumption. This analysis is closely related to the supply-demand analysis described above and identifies the ability of the various secondary materials to compete as source materials for manufacturers. A number of factors were examined such as price changes in the secondary materials, the availability of materials, and the effect of sudden changes in the magnitude of demand.
- (5) Direct Impacts of Technological Change. Direct technical and technological factors were examined to determine their effect on rates of processing and recycling. Potential changes that could take place in technology that could decrease or increase the rate of solid waste recovery were examined. This includes the identification of potentially recoverable solid wastes, the problems limiting the recovery to current levels, and the possibilities of technical advances through the use of known technology or through added scientific and engineering research.

(6) Constraints on Expansion of the Secondary Materials Industries.

This analysis included consideration of elements critical to expansion of recycling - labor and management availability, laws and regulations, equipment availability, nature of solid waste materials, market needs, etc.

(7) Potentials for Expansion of the Secondary Materials Industries.

Based on the constraints identified in the above task, plus examination of various methods for overcoming constraints, this task determined the ability of the secondary materials industries to meet new opportunities for recycling.

(8) Indirect Technological Change. The broad overall technological trends indirectly affecting the secondary materials industries were examined, and their probable impacts determined.

Organization of the Paper Report

Following (1) the summary of the entire paper report and recommendations and (2) this introduction, the reader is led through a series of sections which follow the flow of wastepaper and paperstock from sources to users. The earliest discussions cover the origins or sources of wastepaper, some of which is eventually collected and processed into the form of paperstock. The succeeding discussions cover collection, processing, and distribution of the commodity and characteristics of the dealer/processors as determined from the extensive survey data. Next, the uses and markets for paperstock are discussed.

The section following presents discussions of all of the factors identified as constraining recycling. Another section discusses the dynamic and changing aspects of the paperstock industry. The final section presents the conclusions and recommendations, and includes identification of those activities which, in the judgement of the Battelle- Columbus research team, appear most feasible to pursue. The most logical participants in these recommended actions, also, are identified.

In the preparation of a technical report of this type, the authors are aware of the fact that the work, eventually, will be exposed to a variety of types of readers with different backgrounds and different interests. It is felt that the sequence followed in this report will appear helpful and logical to the greatest number of readers, those who have little or no prior exposure to all aspects of the wastepaper and paperstock industry. However, those readers who feel they already have a substantial background in this area are invited to follow a reading sequence to suit their own specific needs. For example, such a reader might logically move directly from the section dealing with summary and recommendations to the sections reviewing constraining problems and conclusions and recommendations; and then, if he so desires refer to the intermediate sections detailing the flow of wastepaper and paperstock.

ORIGINS OR SOURCES OF PAPERSTOCK

This section of the report deals with the sources from which waste-paper may be collected for purposes of recycling or for disposal. The combined output of these sources represents the total potential supply of wastepaper which may be diverted, in the form of paperstock, to recycling channels or which may be permitted to flow into solid waste channels. It should be recognized that wastepaper is not deliberately manufactured, but is involuntarily generated by a great number of sources without any consideration of the paperstock needs of the marketplace or the capacity of the environment to absorb this material along with other solid wastes.

Forms of Wastepaper

In general, there are three broad forms of wastepaper characterized by the circumstances under which they are generated. These are:

- (a) Production or conversion waste -- the waste generated in paper and paperboard mills, or by converting or printing plants. That waste generated at the mill level through manufacturing error, conventionally designated as wet or dry "broke", when returned to a re-pulping unit in the mill for reprocessing, is not generally counted as wastepaper. The cuttings or sheets, either printed or unprinted, generated at the converting or printing plant levels are, however, classified as wastepaper if it is necessary for them to move through external channels before being returned for reprocessing.

- (b) Overruns or overissues -- excess quantities of finished paper or paperboard products which cannot be marketed through the channels originally planned. Overruns of particular specification papers, custom printed papers or packages or overissues of newspapers and other periodicals are marketed or otherwise disposed of as wastepaper either by the producers or purchasers of these items rather than the originally planned end users.
- (c) Discarded end products -- paper and paperboard products which have reached end users and served the purposes for which they are intended or which have outlived their usefulness. Such wastepaper can range from yesterday's newspaper to the wallpaper in aged tenements being razed to provide space for new construction.

Wastepaper and Paperstock Categories

From the standpoint of the wastepaper generator, the designations for the categories of wastepaper with which he is concerned are, quite simply, the same as those for the end products themselves which now represent waste. In short, when the generator considers the components of his solid waste, he is inclined to think in terms of old envelopes, bags, newspapers, magazines, cardboard boxes, etc. The great number of categories of wastepaper which might be established on this basis is evident when one considers the detailed listing of paper and paperboard classifications in Table 1 based on U. S. Department of Commerce Census Bureau SIC designations. Tables 2 and 3 show total and per capita U. S. consumption of major grades of these products. It is more

TABLE 1. STANDARD INDUSTRIAL CLASSIFICATIONS RELATING TO
THE PAPER, PRINTING, PUBLISHING AND ALLIED INDUSTRIES

Group No.	Industry No.	Description
261	2611	Pulp Mills
262	2621	Paper Mills, Except Building Paper Mills
263	2631	Paperboard Mills
264	2641	Paper Coating and Glazing
264	2642	Envelopes
264	2643	Bags, Except Textile Bags
264	2644	Wallpaper
264	2645	Die Cut Paper and Paperboard and Cardboard
264	2646	Pressed and Molded Pulp Goods
264	2647	Sanitary Paper Products
264	2649	Converted Paper and Paperboard Products, Not Elsewhere Classified
265	2651	Folding Paperboard Boxes
265	2652	Set-up Paperboard Boxes
265	2653	Corrugated and Solid Fiber Boxes
265	2654	Sanitary Food Containers
265	2655	Fiber Cans, Tubes, Drums, and Similar Products
266	2661	Building Paper and Building Board Mills
271	2711	Newspapers: Publishing, Publishing and Printing

TABLE 1. STANDARD INDUSTRIAL CLASSIFICATIONS RELATING TO THE
PAPER, PRINTING, PUBLISHING AND ALLIED INDUSTRIES (Cont'd.)

Group No.	Industry No.	Description
272	2721	Periodicals: Publishing, Publishing and Printing
273	2731	Books: Publishing, Publishing and Printing
273	2732	Book Printing
274	2741	Miscellaneous Publishing
275	2751	Commercial Printing, Except Lithographic
275	2752	Commercial Printing, Lithographic
275	2753	Engraving and Plate Printing
276	2761	Manifold Business Forms
277	2771	Greeting Card Publishing
278	2782	Blankbooks, Loose Leaf Binders and Devices
278	2789	Bookbinding and Related Work

Source: Standard Industrial Classification Manual, Bureau of the Budget, 1967.

TABLE 2. UNITED STATES PAPER AND BOARD PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION - 1969

	<u>Production,</u> Thousands of tons	<u>Imports,</u> Thousands of tons	<u>Exports,</u> Thousands of tons	<u>Apparent Consumption</u> Thousands of tons	<u>Pounds per Capita</u>
All grades	53,481	7,493	2,766	58,209	572.9
Paper	23,460	7,186	619	30,027	295.5
Paperboard	25,553	23	2,083	23,493	231.2
Wet machine board	134	9	4	139	1.4
Construction paper and board	4,332	275	59	4,550	44.8

Source: The Statistics of Paper - 1970 Supplement, American Paper Institute, p. 24, 25, 30.

TABLE 3. UNITED STATES PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION PER CAPITA
OF SELECTED GRADES OF PAPER, 1969

Grade	Production, Thousands of tons	Imports, Thousands of tons	Exports, Thousands of tons	New Supply, Thousands of tons	Consumption, Pounds per Capita
Newsprint	3,163	6,790	127	9,826	96.7
Ground wood paper - uncoated	1,153	204	6	1,351	13.3
Coated printing and converting	3,330	-----	70	3,260	32.1
Book, uncoated	2,585	47	9	2,623	25.8
Writing and related	2,912	13	82	2,843	28.0
Bleached bristols	973	-----	---	973	9.6
Unbleached kraft, packaging and industrial converting paper	3,867	59	127	3,799	37.4
Packaging and industrial converting paper except unbleached kraft	1,270	10	21	1,259	12.4
Special industrial paper	585	-----	54	532	2.6
Tissue and other machine creped paper	3,620	-----	20	3,600	35.4
Sanitary paper	3,378	N. A.	17	3,360	33.1
Tissue paper except sanitary and thin	242	N. A.	2	240	2.4

Source: The Statistics of Paper - 1970 Supplement, American Paper Institute, p. 26, 27.

conventional, however, for wastepaper processors and users, as well as big generators, to think of wastepaper grades in terms defined by the Paperstock Institute of America. In its circular PS-70 the Institute lists 46 individual grades of paperstock "as they should be packed and graded" for sale through recycling channels.

Individual dealer/processors may market as many as 100 different grades of paperstock, a great number of which are custom packed to meet the specifications of particular customers. Broadly speaking, there are five general categories of paperstock each of which includes a number of stock PSIA grades or custom packs. These five grades, according to Bureau of the Census codes for materials consumed in manufacturing are as follows:

<u>Code</u>	<u>Grade</u>
941111	Mixed papers (e.g. office waste basket contents, used business forms)
941112	News
941113	Corrugated
941114	High grade pulp substitutes (e.g. kraft cuttings, white ledger stock, shavings)
941115	High grade deinking (e.g. No. 1 books & magazines; colored ledger stock)

Considering these five grades, it is also common to combine the mixed, news, and corrugated into one category designated as "bulk grades" or "low grades" and to designate the two remaining grades simply as "high grade" paperstock. These designations, it may be noted, refer to the amounts available or the desirability and value of the grades for recycling applications rather than the nature of the paper or paperboard products which make up the wastepaper. For example, a particular low grade pack of paperstock might contain what were

originally high quality and high value converted paper or board products but would be classified as low grade because of the presence of plastic coatings or adhesives that reduce the value of the pack in recycling channels.

In the sections following, the categories of wastepaper generated by each of the various classes of generators are discussed. It may be noted that the components and character of the so-called "mixed" grade differ substantially by type of generator. The other grades are fairly constant as to their components but are, in some cases, limited as to the number of sources from which they may be collected.

Generators of Wastepaper

Broadly considered, there are two general categories of wastepaper generators -- consumer and industrial -- just as there are two general categories of markets for the output of paper and paperboard mills and converters. While there are no precise data as to the amount of paper and paperboard products which reach consumers as compared with the amount shipped to industries, it is generally conceded that the industrial sector is by far the greater of the two. This is accounted for, to a large degree, by the fact that so great a proportion of corrugated shipping containers, which constitute a large part of overall paper production, never reaches consumers. In order to gain a clear understanding, however, of the types and character of wastepaper generated in these two broad sectors, it is necessary to consider the individual components of these sectors, separately, and the kinds of wastepaper generated within them.

The Residential or Household Sector

As has been indicated above, this sector receives far less paper and, therefore, generates far less wastepaper than do the industrial sectors. The residential category includes all forms of households -- single family, multi-family, low, medium, and high income, and urban, suburban, and rural. Broadly speaking, the residential sector generates only two categories of wastepaper, in line with the definitions employed in this section of the report. These are the news grade and the mixed grade of wastepaper. Old corrugated and the two high grades of wastepaper are not generated to any appreciable degree.

Of the two grades generated, only the news grade is currently being recovered and recycled to a significant degree. This is because old newspapers are relatively easy to segregate from other forms of household waste. Substantially larger quantities of old news could be recovered from household waste, but thus far, the demand for old news as a paperstock commodity has not been great enough to maximize segregation and collection.

The mixed grades of wastepaper generated in residential sources consist mostly of packaging materials which have become contaminated through use and as a result of becoming mixed with other forms of household wastes. These mixed papers historically have been rarely recovered and recycled because of difficulties in segregating them at the source and the relatively small quantities generated at individual sources. Recent efforts, however, have been made to separate paper fibers from collections of municipal wastes but the long-term opportunities for success in these activities are not yet clearly known.

The various forms of paper products constituting the mixed paper category in residential waste for the most part include the following:

- (a) Folding cartons -- these paperboard containers move through consumer channels for a wide variety of end uses. Among these are various wet and dry food products, cosmetics and soap, beverages (carriers), hardware, appliances, medicinal products, etc. The differences in types of paperboard, coatings and inner linings used in the construction of these cartons tend to complicate efforts to segregate these cartons by categories from residential waste.
- (b) Milk containers -- these paper containers used extensively in residences, are heavily coated with plastic. The technology for recycling these containers after segregation from other forms of residential waste is still in the developmental stages.
- (c) Magazines -- most medium and high income residences generate fairly large quantities of a wide variety of publications. Because of the coatings used on the paper, the adhesives used in the bindings and other contaminants so often found in these publications, magazines have insignificant value in recycling channels under present technologies.
- (d) Kraft bags and wrappings -- most homes collect fairly large quantities of grocer's sacks and other kraft wrapping or packaging material, some of a seasonal nature. The sacks are popularly used as containers for other household trash, and along with the other kraft materials become contaminated and undesirable for recycling purposes.

- (e) Paper plates, cups, etc. -- these disposable items, generated with a high degree of seasonality, for the most part, become wet and contaminated through use and are therefore undesirable for recycling under present technologies.
- (f) Other disposables (towelling and facial tissues) -- these products, for the most part, become irretrievably mixed with other household wastes in the process of use.
- (g) Other paper products -- those other forms of paper product which normally enter homes include stationery, school supplies, papeteries, books, and all types of incoming personal and merchandising mail. Quantities generated are relatively small and the frequency and volume of movement of them into solid waste channels is unpredictable. Such paper products as decorative wall paper and the linings on gypsum construction boards, for the most part, have very long life cycles and may never reach solid waste channels until the buildings in which they have been used are eventually razed.

For the most part, old corrugated shipping containers do not constitute a major grade of wastepaper generated in the residential sector. Except in rare and unpredictable instances corrugated shipping containers go no further than industrial or retail establishments. When consumers purchase large appliances packaged in corrugated shipping containers, disposal of the containers is often assumed by the vendor. Fairly large quantities of corrugated shipping containers are generated in homes when families move to

new residences but, economic mechanisms for recovery of these relatively small quantities, by comparison with the quantities generated in industries, are difficult to establish.

The high grade pulp substitutes and the deinking grades of paperstock currently originate entirely with industrial and converter generators who generate fairly large quantities of homogenous and relatively uncontaminated wastepaper. Under present technology and economics, the residential sector cannot be logically considered an economic sources of these grades. While every home does generate some wastepaper which might meet the specifications of high grade paperstock users, the high effort of sorting out and collecting these materials from the mix of other paper and nonpaper wastes generated in homes has, thus far, prohibited their recovery.

The Institutional Sector

For the most part, the types of wastepaper generated in the institutional sector including schools, restaurants, hotels, etc., are quite similar to those generated in the residential sector. Because institutions, generally speaking, are larger generators than individual homes, it has been possible, however, to recover and recycle a greater proportion of the paper wastes generated in these sources. Certain paper products such as disposable paper cups and plates, generated in large volume in institutional feeding operations can be more economically segregated and collected from institutional wastes than they can be from residential wastes.

For the same reason, the ratio of recovery of old news and corrugated from institutional wastes is potentially greater than that for residential wastes.

In addition, there are other forms of wastepaper, generated in such institutions as large schools and hospitals, which rarely if ever are found in the residential sector to any appreciable degree. Among these are quantities of duplicating papers, old index cards, file folders, and, in great volume, tabulating cards, when institutions have their own electronic data processing facilities. Finally, some institutions maintain their own in-plant printing operations and generate the same forms of waste printing papers generated in independent printing firms. These additional forms of wastepaper are all potentially collectable and recyclable.

Office Buildings

The forms of wastepaper generated in office buildings vary depending upon the nature of the operations of the occupants of these buildings. Office buildings, both in large and small cities, may contain administrative offices of groups of similar firms or mixtures of many different types of enterprises. In larger cities, like New York and Chicago, there is a tendency for certain types of firms to cluster in particular areas. Some office buildings along Wall Street or lower Broadway in New York City are tenanted almost entirely by stock brokerage and other financial firms. Similarly, advertising agencies have historically clustered in buildings along sections of Madison Avenue in New York.

Also, some office buildings in large cities are tenanted almost entirely by banking firms, insurance companies, or, as in the case of Washington, D. C. and the state capitals, government or state agencies. In general, however, the nature of the wastepaper generated in office buildings tends to be fairly

consistent. The major differences occur when certain office buildings are occupied to a substantial degree by banking or insurance firms which generate large quantities of tabulating cards or by small printing or converting firms which generate cuttings and waste sheets. The tabulating cards, because of their relative homogeneity and fairly light printing, are quite desirable for recycling purposes. The printing and conversion wastes also have potential value depending upon the degree to which they are uncontaminated and may be economically segregated from other wastes.

For the most part, however, office building waste is broadly considered as mixed paper or that which is collected from the many small waste baskets common to facilities of this type. This mixed paper, generally regarded as the grade with the least value in recycling channels, varies in value to the degree to which it contains undesirable contaminants. In office buildings, the list of contaminants may include paper clips, rubber bands, staples, plastic cups and large quantities of carbon paper. The need to remove these contaminants before the mixed paper may be used for even such a utilitarian purpose as roofing paper, governs the value of the mixed paper in the marketplace.

There are two special sets of circumstances which apply to office building mixed wastepaper and not to grades generated in other sources which effect the movement of the commodity. First, wastepaper generated in banks and other financial institutions is commonly stored for periods of up to two months before it is released for disposal. This temporary storage time is generally established to permit employees to look for and recover valuable documents, cash, etc., which may have been inadvertantly discarded.

Second, mixed wastepaper generated in government agencies, and often in private business firms, is frequently, as a matter of policy, run through shredding machines so that information on the paper can not get into unfriendly hands and be used to the disadvantage of the generator. The process of shredding of course, makes it extremely difficult, if not impossible, to remove contaminants from the shredded mixed wastepaper.

While most office employees in large cities commonly bring a morning newspaper to work with them, having read the publication while commuting by public conveyance, recovery of old newspapers from office buildings, for recycling purposes is not widely practiced. Very often, office employees take the newspapers home with them again at the end of the working day. If the newspapers are discarded in the office areas, they are, most often, mixed in with the other office waste and are economically unrecoverable as a distinct wastepaper category.

Again, depending on the nature of the operations of office building occupants, varying quantities of old corrugated boxes are received and discarded. When buildings contain large numbers of printing, converting, light manufacturing or service operations that receive fairly large quantities of supplies in corrugated shipping containers, it is economic for collectors to segregate old corrugated from mixed wastepaper. When the quantities are small, however, in comparison with the greater volume of other forms of mixed paper, segregation generally is not economic.

The Retail Sector

Retail outlets of all types are, generally, large receivers of paper products and therefore, large generators of waste paper. The grade most

predominantly generated, however, is the old corrugated grade since so many consumer products are shipped in corrugated containers to all classes of retail establishments.

The principal retail sector generators of wastepaper are supermarkets, variety stores, department stores, liquor stores, and drug stores. In addition, there are other types of retail establishments including bakery shops, automotive supply dealers, hardware, sporting goods, toys, and retail lumber dealers. Some of these classes of retailers also receive and thereby accumulate fairly large quantities of paper wrapping materials. Many items of apparel, for example, are not necessarily packaged in corrugated shipping containers.

Practices vary sharply as to disposition of wastepaper collected in retail establishments. The governing factor, by and large, is the demand for, and therefore, the value of the wastepaper in a given area. Some big supermarket chains, for example, collect and assemble old corrugated boxes from their stores in particular regions and sell them to dealers or users for reprocessing. In other regions, the same chains make no effort to market the corrugated waste and let the stores dispose of the material individually through solid waste channels. The ultimate disposition of the corrugated in such regions, therefore, may take the form of either incineration, dumping, or sanitary land fill.

Because of current pressures to control incineration practices so as to reduce air pollution, some of the material formerly burned is probably being recycled through the efforts of trash haulers faced with limitations in dumping or land fill space in which to dispose of the material.

During the intensive field interviewing phase of the research program on which this report is based, two department stores located within blocks of each other in a large city in the East were visited. One of the stores has established a policy of incinerating on the premises all of the wastepaper generated in the establishment. While no accurate records are maintained as to the amounts of such wastepaper generated, it was reported that the store's gas fired incinerator operates constantly from 8:30 in the morning until 9:30 every night. It has a capacity of between 800 and 1,000 cubic feet, so it is estimated to burn between 25 and 30,000 cubic feet of wastepaper per day including such potentially valuable paperstock items as tab cards and sheets. The liquor department, alone, during the holiday season, generates as many as 300 to 400 empty corrugated liquor cases a day all of which are burned. When there are special sales in the store, as for example, in the shoe department, thousands of empty shoe boxes are generated and burned per day.

In the neighboring competing store, the policy and practice is quite the opposite. This establishment generates an average of approximately 10 tons a day of wastepaper including corrugated. Approximately 70 percent of this wastepaper, or the cleaner material with a minimum of contaminants such as carbon paper, is baled in the store and sold to a local paperstock dealer. The costs of the necessary sorting and baling, reportedly, substantially exceed the revenue which the store receives for the baled wastepaper. However, the store's cost studies have shown that the real and intangible costs of adopting other methods of disposal would exceed the present net loss on handling wastepaper. The costs of operating a crew of incinerator personnel, plus the

high cost of maintenance on an incinerator, along with the safety risks and the danger of violating air pollution codes have all been realistically reviewed in this instance.

The Wholesale Sector

In general, wholesalers, distributors, or jobbers, as these enterprises are variously designated, are not considered to be large generators of wastepaper in comparison with other sectors. Wholesalers in most industries and particularly in consumer product lines, traditionally perform more of a warehousing function than a repackaging function. Accordingly, the packaging papers and shipping containers which these organizations receive, in the course of their business operations, are generally passed along, intact, to retailers who must eventually assume the responsibility for disposing of these materials.

There are, of course, some exceptions to this general observation. Distributors of newspapers, magazines, and other publications, typically generate fairly substantial quantities of overissue news and magazines. Practices vary regionally and in terms of types of printed material as to disposition of these forms of wastepaper. In some cases, materials are returned to the publishers for disposition and in others, the materials are marketed or otherwise disposed of by the wholesalers. Depending upon the local market demand, this wastepaper may have relatively high value in recycling channels. Over issue news, for example, may move, through recycling channels, to several reprocessing end uses including deinked newsprint and folding boxboard. Over issue magazines, on the other hand, currently, have low value to reprocessors because of the contaminants such as heavy clay coatings, binding adhesives, and difficult-to-remove plastic inserts which they so often contain.

Those industrial distributors and other wholesaling organizations who perform grading and repackaging functions, as has been indicated earlier, do generate some quantities of waste packaging papers and board and cannot reuse these materials in their own shipping operations. (Wholesalers of drugs, toiletries, hardware, sporting goods, and toys, for example, very often endeavor to use incoming corrugated shipping containers as containers for outgoing small orders of a variety of items for delivery to dealers.) Again, the method of disposition of the unresuable packaging materials depends entirely upon the nature and condition of the materials and the local demand for them in recycling channels. If the material is relatively clean and free of contaminants and may be readily segregated from other forms of waste, wholesale generators may find it economic to market the materials to dealers or users. On the other hand, if the waste consists largely of containers heavily coated with wax or other formulations to keep them "rigid-when wet", the waste is generally unattractive to end users.

As in the case of administrative headquarters for retailing organizations, the office waste of wholesaling organizations is roughly comparable to that grade of mixed papers generated in office buildings and discussed in an earlier section of this report.

The Transportation Sector

All firms in the various areas of the transportation industry -- railroads, airlines, bus lines, etc., -- generate quantities of wastepaper above and beyond that generated in their administrative office operations. The only grade, however, of any real significance is old news found principally

in local and suburban railroad cars, subway cars, and buses and terminals. The used newspapers are discarded, for the most part, by relatively short-distance commuters en route to their places of employment.

Where sufficient demand exists for old news, as in New York City and Chicago, it has been economic for transportation company employees or employees of wastepaper collection firms to sort out old newspaper from the other forms of waste generated in transportation facilities. These other forms of wastepaper, broadly classified as mixed paper waste, include magazines, other publications, and a wide range of forms of waste packaging papers including wrappers for candy, gum, cigarettes and cigars, all for the most part, far too contaminated to permit economical reprocessing.

The Printing and Converting Sector

Printers and converters of paper and paperboard products generate all categories of wastepaper and are the largest source of the wastepaper currently being recycled. A comprehensive study of solid waste management practices in the printing and publishing industry was recently completed on behalf of EPA and includes substantial data on the types and amounts of wastepaper generated by newspapers, periodicals, book publishers and printers, commercial printers, both lithographic and non-lithographic, and related types of establishments.*

* Solid Waste Management in the Printing and Publishing Industry, a report prepared for the Bureau of Solid Waste Management under contract CPE-69-6 by Battelle Memorial Institute.

In general, because of the relative homogeneity of the wastepapers generated in printing plants, recovery ratios are high at least for the waste-paper generated in the larger establishments and those geographic areas where demand exists. Newspapers, which generate as many as 7 or 8 different grades of wastepaper including newsprint mill wrappers, unprinted newsprint from the outer or inner plys of rolls which, for one reason or another, do not get on the press, printed news in the form of overissues, etc., generally market a greater share of wastepaper than do other printing establishments. Printers of books and magazines generate a wider variety of types of wastepaper than do newspapers, because of the more varied nature of the printed end products. Similarly, commercial printers handling broad ranges of custom printing jobs, generate even wider varieties of wastepaper than do printers of newspapers, periodicals, or books. The variations in grades of papers used and the degrees to which these papers are covered with ink are quite pronounced in the commercial printing industry.

Generally speaking, however, the printing industry, overall, is a good source of both the high grade pulp substitutes and high grade deinking categories of wastepaper. These grades are principally generated during the cutting and trimming operations. Newsprint, both printed and unprinted, of course, is generated principally by the newspaper segment of the printing industry although some book and magazine printers generate quantities of these grades as well.

All segments of the printing industry generate quantities of mixed papers. The components of these mixed papers, the degrees to which they are contaminated, and hence, the value of these mixed papers in the marketplace for recycling purposes depends upon the nature of the operations of the particular

generating printing establishment and the degree to which segregation or sorting of wastepaper is practiced at the source.

The converting sector is composed of many thousands of individual companies who produce a wide range of paper and paperboard products, both printed and unprinted. Among these products are such familiar items as envelopes, bags, filing folders, index cards, folding paperboard boxes, setup paperboard boxes, corrugated and solid fiber shipping containers, cups, pails, fiber cans, tubes, drums, etc.

All of the producers of these items generate waste in the form of trimmings and cuttings to some degree. Obviously, like printers, these converters make every effort to keep waste to a minimum so as to maximize usage of raw materials purchased. However, some waste is unavoidable, in spite of careful control of sheet or web widths and the layout of items to be die cut. Again, the value of the waste materials thus generated, and the likelihood of such waste materials being reprocessed depends upon the nature and the condition of the materials and how well they are segregated or sorted. Generally speaking, however, paper and paperboard converters are attractive sources of both high-grade pulp substitutes and high-grade deinking categories of wastepaper because of the relative homogeneity of the wastepapers generated. Envelope converters, in particular, along with producers of file folders, unprinted index cards, etc., are most attractive sources of these grades. Indeed, with a minimum of effort on the part of the generator, such high grades of wastepaper can be and are shipped directly from generator plants to the mills which ultimately reprocess them.

Paper and paperboard converters, for the most part, do not generate any appreciable quantities of old news other than that discarded by plant or office employees. Converters, like printers, do however, generate quantities of old corrugated in the form of incoming shipping containers, single or double-faced corrugated wrappings around incoming shipments of raw materials, and, in some instances, disposable corrugated pallets.

Finally, paper and paperboard converters, like printers, generate quantities of mixed paper or that wastepaper remaining, generated in both production and office operations, after the higher grades of more homogenous wastepaper and paperboard have been culled out. Clearly, the components of this residual mixed paper generated in paper and paperboard converting operations are quite different from those mixed papers generated in other sources and, may, in many instances, be much more desirable and command higher prices in the marketplace.

The Service Industries' Sector

Service industries, as herein considered, include a wide range of communications, electric, gas, water, and related services. For the most part, the wastepaper generated at these sources is quite similar to that generated in office buildings, institutions, wholesale organizations and to some extent the residential sector. Firms in the service industries sector, are, however, particularly large generators of electronic data processing tabulating cards and related forms and sheets which have outlived their usefulness. Here again, the nature of wastes generated are somewhat similar to that generated in banks and insurance companies. Accordingly, service industries are attractive sources of the higher grades of wastepaper in which these relatively homogeneous products may be included.

Service industries are not generally identified as large generators of either old corrugated or news. The corrugated generated, is for the most part, that received in connection with incoming shipments of supplies. Again, the only old news generated is that discarded by plant and office employees at work.

In the communications segment of the overall service industries sector, the question of who, in fact, actually "generates" the many millions of outdated telephone directories discarded each year, remains unanswered. For many years telephone companies made conscientious efforts to collect their old books when the new ones were distributed. Reportedly, these efforts were never wholly successful but one company did, at one time, recover as many as 45 percent of the old books. These were then disposed of through recycling channels. In recent years, however, telephone companies have discontinued their efforts to recover the old books when it became clear that the cost of recovery was too high.

As a result of this discontinuance of collections, the problem of disposing of the expired directories rests with the telephone company subscribers. The magnitude of the problem is demonstrated by the fact that some 2,400 different telephone directories, using 140,000 tons of paper are distributed in the country every year.*

As in the case of other forms of wastepaper discussed in preceding sections of this report, the value of these old telephone directories is diminished when the directories are mixed in with other forms of wastepaper and other forms of solid waste. This mixture is, for the most part, unavoidable when the disposal of the directories in relatively small individual quantities, becomes the responsibility of the many millions of telephone subscribers in the country.

* "Old Phone Books Posed a Problem", The New York Times, January 10, 1971, p 55.

Other Industrial and Commercial Sectors

In the introductory portion of this section of the report, it may be recalled, the point was made that there are two general categories of wastepaper generators -- consumer and industrial/commercial -- just as there are two general categories of markets for the output of paper and paperboard mills and converters. In order to gain a clear understanding of the types and character of wastepaper generated in these two broad sectors, it was necessary to review the individual components of these sectors separately, the kinds of wastepaper generated within them and to identify those categories of wastepaper which, currently, are moving into recycling channels from these sources.

Broadly considered, the residential sector and that part of the institutional sector made up of hotels, motels, and to some degree, hospitals, may defensibly be included in the overall consumer category. All the other sectors reviewed -- office buildings, retailers, wholesalers, transportation companies, printers, converters, and service industries may be considered in the industrial or commercial category, although some exceptions to this generalization are apparent.

Still remaining are all of the additional industrial and commercial enterprises which make up the American economic structure. These sectors include all other manufacturing firms, agricultural, mining, construction enterprises, etc. All of these, understandably, also receive paper products in some forms in the course of their operations and hence, generate varying amounts of wastepaper. The grade generated in greatest volume in all these industries must necessarily be designated as the mixed paper grade because of the heterogeneous nature of the input. Because of the existence of constraints similar

to those touched on in discussions of other generators, very little of this mixed paper currently moves into recycling channels compared to the volume generated.

Old corrugated is also generated in substantial volume in these remaining types of enterprises as a result of receipt by these enterprises of substantial quantities of shipping containers, corrugated overwraps, etc. The automotive and aircraft industries, for example, generate substantial quantities of old corrugated. Where there is sufficient demand for this material to justify the effort and expense of segregating and baling it, considerable quantities of old corrugated generated in these sources are moving into recycling channels.

The third distinct grade of wastepaper generated in these industries consists of the tabulation cards and sheets which, when appropriately segregated can potentially move through recycling channels as high grade deinking paperstock or high grade pulp substitutes. Old news is not distinctly an identifiable grade of wastepaper generated in these industries. However, it is obvious as in the case of office buildings and other industrial sectors described, that these remaining industries do generate substantial quantities of old news discarded by office and plant employees. Again, depending upon the demand for this grade in particular areas, it may be feasible for firms in these industries to make efforts to collect and dispose of their accumulated old news to recycling channels.

Table 4 summarizes the origins and sources of waste paper as described in this section in terms of types of waste paper generated by the various sectors of generators discussed.

TABLE 4. ORIGINS OF WASTE PAPER

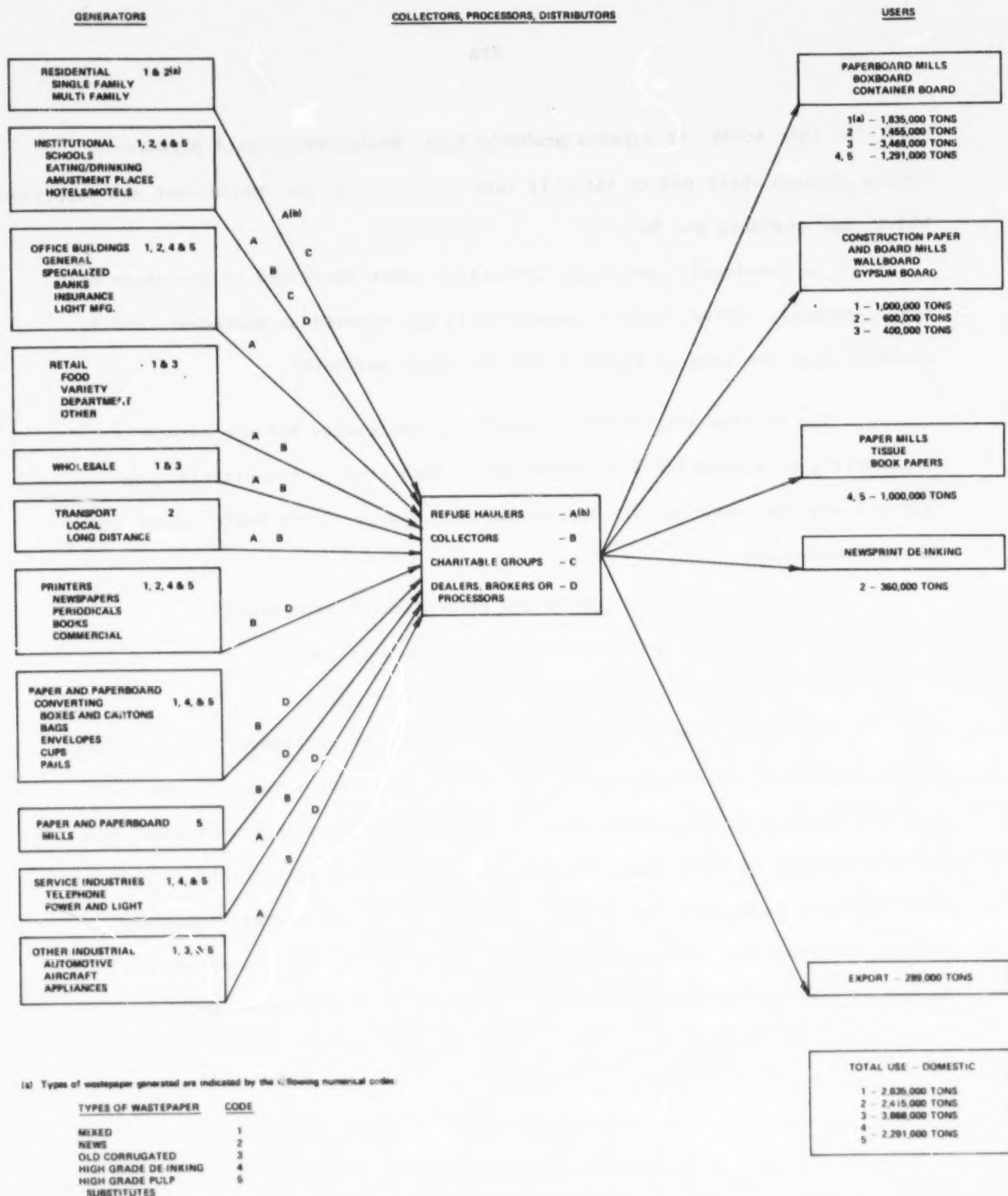
Generators	Types				
	Mixed	News	Old Corrugated	High Grade De-inking	High Grade Pulp Substitutes
Residential	X	X			
Institutional	X	X		X	X
Office Buildings	X	X		X	X
Retail	X		X		
Wholesale	X		X		
Transport		X			
Printers	X	X		X	X
Paper and Paperboard Converting	X			X	X
Paper and Paperboard Mills					X
Service Industries	X			X	X
Other Industrial	X		X		X

PAPERSTOCK COLLECTION, PROCESSING,
AND DISTRIBUTION

The movement of wastepaper from generators to ultimate users of paperstock is accomplished by a wide variety of means and through a number of different types of organizations. The governing factors are the sources of the wastepaper, the types of wastepaper to be moved and the quantities involved. Some wastepaper moves directly from generators to users while other amounts pass through as many as three different organizations before finally reaching the end user's plant.

Figure 1 (Waste Paper and Paperstock Flow Chart) graphically shows the types and amounts of these materials that flow from the generators and ultimately to users. This simplified diagram does not attempt to break out separately the limited quantity of wastepaper that actually is transferred directly from generators to users. (Rather, all of the wastepaper is shown flowing through the central box, which represents refuse haulers, collectors, dealers, etc.) Precise statistics on the amount of wastepaper or paperstock flowing directly from generators to users are not available, and even available estimates may be in error. Battelle believes that at least 80 percent of all wastepaper and paperstock recycled in the United States is handled to some degree by the paperstock industry.* Another source feels that the proportion handled by the paperstock industry is well above 90 percent at present and was very close to 100 percent in the recent past. In this context, "handling" could range from performing a brokerage function (without physically handling the wastepaper) to actually sorting and processing the wastepaper. On the basis of a survey completed by

* Captive dealer/processors owned by paper companies, such as Pioneer Paper Stock Division of Container Corporation of America (Marcor), are defined as part of the paperstock industry.



Source: End Use Statistics - Unpublished data from Paperstock Conservation Committee, American Paper Institute.

NASMI for this study, it appears probable that dealer/processors physically handle through their plants slightly less than half of the wastepaper and paperstock which they purchase and sell.

As previously indicated, production waste generated at the paper mill level, commonly called "broke", generally is not counted as wastepaper and is excluded from the data on Figure 1 and the above estimates.

The various alternative channels for wastepaper and the nature of the handling or processing that may occur at each step in the distribution channels are discussed in this section of the report. Three basic routes are traced. These are:

- A. The route from generators to dealers or processors
- B. The route from dealers or processors to users
- C. The route from generators directly to users.

The discussions of handling or processing of wastepaper or, in effect, making paperstock out of wastepaper, convey the fact that various degrees and forms of handling or processing occur at all of the stages in the channel, but the greater part of these functions are performed by the specialists in this work, known as paperstock dealers and participants in the overall secondary materials industries. The number of these organizations and the volume and nature of their activities are reviewed in detail in a subsequent section of

this report based on tabulations and analyses of the extensive survey conducted by NASMI.

The Route from Generators to Dealers or Processors

In order to consider the alternative routes for wastepaper from generators to processors we must reflect on who the generators are and the kinds of wastepaper they generate as discussed in the preceding section of this report.

Movement From the Residential Sector to Dealer/Processors

In the residential sector, the grade most generated is generally categorized as mixed paper and consists of all forms of paper products, including the many forms of packages used in homes. For the most part such paper is not separated from other forms of household waste. This mixed paper, except for pioneering experiments in certain cities never reaches processors and moves instead in the trucks of municipal or independent trash haulers directly to dumps, sanitary landfill projects, or incinerators.

In some cases transfer stations have been established where household refuse is temporarily collected after being deposited there by local collection trucks so that it may be transferred to other vehicles for more economical transport to distant sites. The pioneering experiments and other methods of residential waste disposal include, notably, the operation of a one-ton per-hour-capacity "Hydrasposal" system pilot plant in Middletown, Ohio, by Black Clawson Company. EPA has authorized as a demonstration project, a 150 ton-per-day installation in Franklin, Ohio, which is

presently under construction by the same company. Under this system, residential waste is hauled directly to the pilot plant. About half of this waste tends to be paper and paper products. The machine breaks up and rejects nonfibrous materials and retains the fibrous material to be repulped. Other methods of separation and recovery of wastepaper from residential trash are under study. These include an air classification technique.

In some communities where sanitary landfill projects are maintained, residents are also permitted to transport excess quantities of accumulated household wastes in their own vehicles to the landfill sites during certain hours on specified days. By and large, however, most of the mixed paper wastes generated in individual or multi-family residences, both urban and rural, are hauled away to disposal sites without further processing, other than compacting in the trash hauler truck and do not enter recycling channels. The relatively recent introduction of household trash compactors serves principally to reduce the volume, but not the weight, of paper and other wastes generated in the home and does not affect the ultimate disposition as presently foreseen. Conceivably, if all of the residences in a given area were to install these appliances, there might be no need or use for the compacting equipment which is conventional in most local trash haulage trucks.

While, for the most part, old newspapers generated in residences move along with the mixed papers and other wastes to disposition sites described in the foregoing paragraphs, substantial quantities have moved in the past, and

will continue to move, into recycling channels. Because of the fairly uniform sizes of newspapers and the way in which they are folded, it is fairly easy to segregate and collect old news in the average residence. Because of the bulk of collected newspapers, housewives are reluctant to deposit them in the trash containers in the kitchen and other rooms in the residence. This is also true, of course, to some degree of old magazines, but generally, these are not collected in as great volumes in homes as are newspapers.

Whenever sufficient pressure is exerted, through the form of appeals to either patriotic or ecological feelings, great quantities of old news may be collected from the residential sector and recycled. There are really only one or two factors that inhibit collections. One is the need for the resident, in most cases, to find space in the garage or basement of the home, in which sufficient quantities of old news may be stored prior to disposition. The other is the necessity, generally, that the resident tie the newspapers into bundles, so that they do not blow around outdoors, before disposition.

Several methods have been identified for moving old newspapers from the residential sector (and other sectors as well) to dealers and processors for eventual recycling.* These are:

- (1) Pickup at curb by professional scavengers. In San Francisco, stimulated by the efforts of the local newspapers, householders put their papers on the curb separately from other solid wastes so that the professional scavengers may pick them up with ease.

* "Recycling Wastepaper into Newsprint", a presentation by Richard B. Scudder, Chairman, Garden State Paper Company at the API Seminar on "Recycling Wastepaper", October 16, 1970, Washington, D. C.

- (2) Pickup by charities. In Union, New Jersey, charities such as The Salvation Army, Goodwill Industries, the Boy Scouts, and other such organizations come directly to homes and collect the accumulated newspapers.
- (3) Compulsory segregation. The community of Irvington, New Jersey, passed a law which requires that householders must put their papers separately on the curb once a month. The accumulated papers are picked up by charities such as those named above. This program provides an income for the charities and, reportedly, reduces the city's refuse service cost by about 20 percent.
- (4) In San Diego, California, drop boxes are set out in convenient locations by charitable groups and householders are asked to deposit their old newspapers periodically in these boxes. Two hundred such boxes were set out in San Diego by the local Kiwanis Club and, for every full box, the youth activities that the club sponsors get \$5 and the city salvage operation gets \$8.

There are, of course, potentially, many variations on these four methods of moving old news into recycling channels. In some instances, drop boxes are placed in communities by large captive dealer organizations. In a growing number of cities, householders put out their bundles of newspapers along with their other trash and the community's trash hauling trucks pick up the bundles while making their regular rounds. Special racks have been slung under the trucks to contain the bundles of newspaper and keep them separate from the other trash.

As has already been noted, the residential sector does not receive nor generate significant quantities of old corrugated. Consequently, that which is generated, for the most part, is disposed of into solid waste channels along with other mixed papers and it never reaches the dealers or processors. The same is also true of the relatively small individual quantities of residentially generated wastepaper which, if they could be readily segregated from or culled out of the mixed papers generated, might be classified as high-grade paperstock. Actually, it is these "relatively small individual quantities" generated in the residential sector which, in the aggregate, constitute much of the unrecycled wastepaper generated today. In short, the problem to society is not with the high grades of paperstock which are being recycled but, rather, the bulk grades of wastepaper which move into solid waste channels.

Movement from the Industrial/Commercial
Sector to Dealer/Processors

The industrial/commercial sector, as defined earlier in this report, includes all of the institutions, office buildings, retail and wholesale establishments, transportation companies, printing and converting plants, service industries and all other enterprises that generate wastepaper in the course of their business activities. As has been noted, the kinds, the amounts, and the conditions of the wastepapers generated in this sector vary widely. Further, the value of or the likelihood of recycling these wastepapers differs substantially from industry to industry, from company to company, and from one geographic area to another.

Although the urgency is obviously much greater in highly populated built-up metropolitan areas, there is one pressure that appears to be common to all industries. That is the need and desire to be rid of waste materials generated as quick as possible. The reason for this desire, obviously, is the realization that waste materials, when stored on the premises, consume valuable space which could be more productively devoted to profitable activity. Further, accumulations of waste materials, and particularly such highly flammable materials as wastepaper, create hazards and tend to detract from the appearance of an establishment. In big cities, where space is at a premium, generators cannot tolerate the accumulation of bulky quantities of wastepaper for more than several days at the most. Indeed, instances have been reported when big city newspapers have been forced to suspend operations because unusual circumstances, like a blizzard, have interrupted the movement of wastepaper generated out of the printing plants.

The form in which wastepaper is moved from generator's establishments to dealers or processors depends upon the amount and type of wastepaper generated, which, in turn, determines the degree to which the generator is equipped to semi-process and bale the wastepaper generated. Generators of fairly homogeneous wastepaper in large quantities, such as printers/converters, usually do some segregating of wastepaper by general categories. The segregating may be accomplished either through the use of a vacuum duct system in the plant which automatically keeps different types of waste separate or by the manual efforts of plant workers assigned to the task. Most large generators also have baling equipment used simply to reduce the amount of space occupied by accumulated wastepaper until it is removed from the premises.

Much wastepaper, however, is moved in loose form contained in burlap or paper bags to the facilities of refuse contractors or paperstock processors. The bags, or, in some cases carts, are frequently the property of the refuse contractor or processor who leaves a fresh supply at the generator's plant when he removes the filled bags or carts. Generally speaking, it is not economical to haul wastepaper in loose or bag form for more than relatively short distances because of the low value of the material compared with its bulk and weight. This is particularly true of the low grades of wastepaper like the crumpled mixed wastepaper generated in office buildings.

The actual movement of wastepaper from generators' plants to dealer/processors' plants may be accomplished in trucks owned either by the generators, refuse contractors or dealer/processors. In areas where demand for wastepaper is weak, generators may move wastepaper in their own vehicles in order to save the cost of having a refuse contractor haul the material away. In other cases, the generator may elect to use his own vehicles for this purpose in order to get a higher price for the wastepaper delivered to the processing plant.

In short local hauls of wastepaper, some processors who pick up the material from generators use old vehicles no longer suitable for long-distance hauling. Both generators and processors, in general, have demonstrated resourcefulness in the effort to minimize the costs of local movement of wastepaper generated.

The strategic location of a processor's plant is one means of both reducing the cost of movement of wastepaper and stimulating recycling. An example of such a strategic location is that of Edison Salvage Corporation, a new processing facility opened in August of 1970 in Edison, New Jersey.

The facility is "located nextdoor to the town dumps, and the location couldn't be more ideal from the owners' standpoint."* In the words of one of the owners, "what we hope is that trucks from refuse contractors, paper companies, and other industries throughout the area will deposit their clean corrugated and other paper at our specially constructed plant before completing their trip to the dumping ground."

In order to keep the facility economically operative, there is an obligation on the part of the refuse contractors and others who bring their wastepaper to the facility to separate their corrugated and paper from other refuse in advance. It is believed that the costs of assuming this responsibility are offset by the savings in dumping costs which the generators or contractors incur when they dump their wastes in open ground landfills, especially since the state of New Jersey recently doubled the price for dumping solid waste in such sites. In addition, the generator or contractor is paid for the separated corrugated and other paper that was previously allowed to go completely to waste.

Again, the foregoing comments apply principally to the so-called bulk grades of wastepaper which contribute most to environmental pollution problems. With regard to the so-called high grades of wastepaper or paperstock, it may be noted that, in most areas, there is active competition among dealers or processors to obtain these grades from generators. In order to earn the privilege of picking up eventually high grade wastepaper from converters and other big generators of high grade materials, dealers will agree to remove all of the wastepaper generated in a plant including in some cases, large quantities of material which has no marketable value. If the dealer demonstrates a desire to be selective about

* Fiber Market News, August, 1970, p 1.

what he will pick up from a good generator, he may find that he is denied further access to this source. Dealer/processors, in such cases, will often also provide the generators with free equipment or equipment leased to the generator at a very low rate, for baling the wastepaper generated. While, this of course, makes it easier and more economical for the dealer to transport the material from the generator's plant to the processing facility, it also serves the purpose of saving the generator space in his own plant until the processor picks up the bales.

Considering the five major grades of wastepaper or paperstock individually, some patterns of movement from generators to dealers/processors become apparent. Old newspapers, for the most part, are transported from industrial/commercial generators to processors by refuse contractors. In some cases, old newspapers are also transported by the charitable organizations who pick up the material from the residential sector. Those old newspapers, overissues or similar categories of old news generated in newspaper plants or in newspaper distribution channels, are, for the most part, picked up and moved to processors' plants in the dealers' own vehicles.

Mixed papers, from office buildings, institutions, and other big generators of mixed papers, are for the most part, moved by refuse contractors although some generators bring them into processing plants themselves. As was noted earlier, the assumption of this responsibility by generators usually is the result of an effort to save the cost of having the waste hauled away. Dealer/processors also pick up large quantities of mixed papers themselves but, usually, only when these lower grades are picked up with higher grades at the same time.

Old corrugated, generated in retail stores and in industrial plants which receive incoming shipments in corrugated shipping containers, etc., is, for the most part, moved to processors by refuse contractors. The pattern at Edison Salvage Company, described earlier, is fairly typical in this regard. However, there are also many instances where generators transport old corrugated to processors or when processors pick up the material in their own vehicles. In the retail segment, some big supermarket chain organizations collect old corrugated boxes from individual store locations and move them to central warehousing points from which they are later transferred to processors' plants, either in the chain's own vehicles or those of the processors. The distances over which it is feasible to transport old corrugated boxes from generators to processors depends largely upon the degree to which the material has been compacted. If individual stores or generating plants have baling facilities at the generating site and can make fairly dense bales, the material, obviously, can be transported greater distances fairly economically.

As to the high grade deinking paperstock or pulp substitutes, movement to processors facilities is, almost without exception, a responsibility assumed by the processor. This pattern, again, stems from the fact that demand is generally quite high for these grades, and processors compete among themselves for the opportunity to collect them from desirable sources. It has been noted, incidentally, that this pattern could also, once again, apply to bulk grades if demand for these grades were to increase significantly in response to new pressures in society.

The Route From Dealers/Processors to Users

One broad generalization that may be safely made is that the higher the quality and value of paperstock produced in processors plants, the greater the distance the material can be shipped to users. Thus, dealer/processors with some notable exceptions tend to cluster relatively closely to the using mills who consume mixed paper, news, and old corrugated. There is no precise pattern, however, as to whose vehicles are used for the relatively local transport of the low grades of paperstock. Further, there is no standard procedure as to who assumes the responsibility for the transportation charges. In some cases, paperstock is shipped "f.o.b. shipping point" and in other charges are prepaid to destinations. How the charges are handled depends entirely upon the terms of the purchase agreement made between the seller and the buyer.

For relatively short distances of movement, the dealer may move the paperstock in his own vehicle. However, there are many instances, particularly in metropolitan areas, where mills pick up the necessary paperstock from the processors' plants on return trips to mills after having completed deliveries of finished paper or paperboard in the same area. If vehicles of both the dealers and the users are unavailable or if it is uneconomic to use them for longer distance transport of paperstock, public carriers' vehicles are used instead. Both rail and truck transport of paperstock are common in domestic movement of this commodity. Export shipments or overseas shipments, obviously, are handled by steamship lines.

With regard to export, at the present time at least, relatively few dealer/processors are engaged in solicitation of foreign markets. Those most active in exporting are principally the larger firms in the industry located

relatively close to seaports. Many of the smaller dealers have little interest in pursuing foreign markets because of the difficulties and cost involved in making export shipments. In the New York City area, particularly, the need to fill out complex sets of business forms, and the losses in time incurred in getting shipments through port facilities are discouraging to the smaller dealers. The larger dealers, having set up special departments for handling export marketing, are better equipped to handle the details involved. Table 5, following, is a statistical compilation of 1969 exports of paperstock showing selected ports of departure, destinations, tonnage, aggregate value, and value per ton. Table 6, following, lists the 6 leading importing countries during 1969 and shows the tonnage and value of the paperstock imported by each.

The Route From Generators to Users

Direct shipment of paperstock from generators to users is relatively common in the paperstock industry. Most of such movement is arranged by generator/processors acting in the roles of "brokers" who, unlike brokers in other industries, actually do take title to the commodity transported. When direct shipment occurs, invariably the generator, e.g., a big envelope converting plant, has established procedures and has adequate facilities to segregate or sort wastepaper generated by grades and to bale it properly for economical shipment.

Many dealer/processors of paperstock operate principally as brokers in this sense, since a relatively small portion (as low as 5 percent in some cases) actually is physically handled through their plants. Depending upon the nature of the grades so brokered, the broker must rely upon the integrity and

TABLE 5. 1969 EXPORTS OF PAPER STOCK FROM SELECTED PORTS

Port of Departure	Destination	Quantity, tons	Dollar Value Per Ton	Dollar Value
New York City, New York	Uruguay	799	41	32,878
	Netherlands	170	25	4,268
	Spain	602	66	40,280
	Italy	7,512	50	375,684
	Lebanon	209	177	37,152
	Indonesia	250	141	35,315
	Hong Kong	125	51	6,458
Charleston, South Carolina	Venezuela	431	51	22,078
	Uruguay	137	94	13,000
	Italy	557	42	23,673
	Philippines	280	67	19,000
	Taiwan	1,108	55	61,281
	Japan	410	62	25,500
	Republic of South Africa	426	99	42,523
	Venezuela	1,816	58	105,923
	Peru	695	60	42,220
	United Kingdom	118	96	11,367
Savannah, Georgia	Netherlands	372	107	40,000
	Italy	13,114	39	514,601
	Japan	120	60	7,200
	Australia	320	32	10,397

TABLE 5. 1969 EXPORTS OF PAPER STOCK FROM SELECTED PORTS (Continued)

Port of Departure	Destination	Quantity, tons	Dollar Value Per Ton	Dollar Value
Los Angeles, California	Venezuela	1,360	58	79,286
	Netherlands	201	47	9,612
	Italy	1,511	16	24,186
	Thailand	2,107	63	133,653
	South Vietnam	720	29	20,910
	Malaysia	583	26	15,200
	Singapore	1,810	34	63,019
	Philippines	4,157	43	181,058
	Korea	2,570	60	156,007
	Hong Kong	150	29	4,450
	Taiwan	652	81	56,280
	Japan	21,349	60	1,300,084
	Australia	2,996	67	201,602
San Francisco, California	Thailand	876	65	57,193
	Singapore	1,096	49	54,233
	Philippines	1,523	63	97,299
	Korea	220	51	11,400
	Taiwan	1,110	70	78,418
	Japan	12,806	57	733,847
	Australia	1,958	76	150,202
	Venezuela	300	39	11,968
	Italy	551	19	10,750
Portland, Oregon	Philippines	1,368	92	126,285
	Korea	1,577	62	98,198
	Hong Kong	120	27	3,270
	Taiwan	1,627	43	71,144
	Japan	13,859	67	940,326
	Australia	263	82	21,578

TABLE 5. 1969 EXPORTS OF PAPER STOCK FROM SELECTED PORTS (Continued)

Port of Departure	Destination	Quantity, tons	Dollar Value Per Ton	Dollar Value
Miami, Florida	Dominican Republic	304	61	18,644
	Venezuela	5,670	40	231,079
	Spain	1,560	26	40,902
	Italy	776	29	22,504
	Japan	824	35	29,427
Total all ports of departure and destinations		288,738	49	\$14,372,861

Source: Unpublished data from Paperstock Conservation Committee. American Paper Institute.

TABLE 6. SIX LEADING IMPORTERS OF PAPERSTOCK - 1969

Country	Quantity, tons	Dollar Value Per Ton	Dollar Value
Canada	84,074	38	3,250,677
Japan	61,406	61	3,776,119
Mexico	42,894	55	2,383,711
Italy	31,571	40	1,266,073
Venezuela	14,173	48	687,705
Philippines	<u>11,163</u>	<u>57</u>	<u>644,769</u>
Total	245,281	48	\$12,009,052

Source: Unpublished data from Paperstock Conservation Committee, American Paper Institute.

efficiency of the generators with whom he is dealing so that his customers, the mills, actually receive the grades ordered. As has been noted in other sections of this report, a mill's inadvertent receipt and use of paperstock contaminated and not of the quality ordered, can ruin the end products and seriously damage mill equipment.

If the quality control considerations are not especially high, as in the case of mills producing unaesthetic products and buying the cheapest grades of mixed papers, the broker is not subject to as much concern as he is when brokering shipments of high-grade deinking or high grade pulp substitute paperstock. Nevertheless, the broker still has an obligation to his customer to provide grades as close as possible to accepted industry standards.

Some quantities of low grades and high grades of paperstock are also shipped directly from big generators to big users without the participation of brokers. When this occurs, the generator, in a sense, assumes the responsibility and role of the broker and negotiates his own arrangements with the users. As such, the generator has the same responsibility to his customers as a broker has, to supply paperstock of the grade and quality specified. The major and very obvious weakness in this system is that the generator's rate of generation of wastepaper is not always precisely in phase with the demands of his customers. Accordingly, the big generator at times may be in a position where he is unable to market his rapidly accumulating waste to his regular customers and must then either find other outlets for it or dispose of it through solid waste channels. When such conditions arise, such a generator may find difficulty in locating a market for his waste that might have been available to him through traditional paperstock brokerage channels.

Although, as has already been noted, generators are under constant pressure to dispose of their wastepaper, the need for them to dispose of it, for the most part, is not so critical as the need for using mills to obtain paperstock when the demand for paperstock end products is high. As a result, some large users of paperstock have established their own dealer/processing captive facilities so that they will always be assured of adequate supplies when needed.

Again, as in the case of movement of paperstock from Dealers to users, there are no precise standard practices as to whose vehicles are used or who absorbs the transportation charges for direct movement of paperstock from generators to users.

Handling or Processing

Processing of wastepaper, or changing the character of wastepaper to make it a marketable commodity in the form of paperstock, is performed only at the generator and dealer/processor levels. The distinctive characteristics of wastepaper processing are that they are essentially dry and cold operations. Except for the use of moisture to minimize circulation of dust, processing of paperstock does not involve the use of water, other liquids or heat in any form as in the processing of scrap metals. The operations which occur at the user mill level, including cleaning and pulping of paperstock

are not normally considered in the broad area of processing, but, rather represent functions undertaken in the course of manufacturing a new product. One possible exception to this generalization is the operation of the Hydrasposal unit by Black Clawson Company in Middletown, Ohio, described in other sections of this report. In the Hydrasposal operation, technically, an intermediate product is the result. As presently developed, this intermediate product requires further processing at the mill level.

Handling or processing, as considered in this section of the report, consists exclusively of segregation or sorting, hogging, or shredding and baling of wastepaper. Each of these operations is described in the sections following.

Segregation and Sorting

Segregating and sorting operations range from the simple activities of the housewife who keeps her old newspapers separate from other household wastes to the sophisticated operations that take place at a modern paperstock dealer/processor plant. In between are many other levels of activities. Among these are the employment of vacuum duct systems in printing and converting plants to maintain separation of grades of wastepaper generated; the activities which take place in a large newspaper printing plant which result in segregating wastepapers generated into as many as 8 different specific grades; and the work of a refuse contractor who pulls out of his collected wastes marketable quantities of old corrugated boxes and newspapers.

Generally speaking, the higher the grade of paperstock desired, the greater the need for quality control and for skill in detecting significant differences in wastepapers generated and the contaminants which they contain.

Clearly, the need for precision or perfection is not so significant in the segregation or sorting operations directed toward the packing of a low grade of paperstock or one with relatively low value in the marketplace.

The PaperStock Institute of America, a commodity division of the National Association of Secondary Material Industries, Inc., has defined "outthrows" and "prohibitive materials" which may be permitted in various standard grades packed and marketed by paperstock dealers.* Outthrows are defined as "all papers that are so manufactured or treated or are in such form as to be unsuitable for consumption as the grade specified." Prohibitive materials are defined as "any materials which by their presence in the packing of paperstock, in excess of the amount allowed, will make the packing unusable as the grade specified, or any materials that may be damaging to equipment."

The PSIA adds further that it is "important to note in connection with (outthrows and prohibitive materials) that a material can be classified as an 'outthrow' in one grade, and as a 'prohibitive material' in another grade". "Carbon paper for example, is 'unsuitable' in Number 2 Mixed Paper and is, therefore, classified as an 'outthrow'; whereas it is 'unusable' in White Ledger and in this case is classified as 'a prohibitive material'."

In the discussions following, the broad term "rejects" is employed to describe both outthrows and prohibitive materials removed in the sorting process at whatever levels such sorting process occurs. Basically, at the processor

* Paperstock Standards and Practices Circular, PS-70, PSIA, January 1, 1970.

level two general methods of sorting are practiced, depending upon the nature of the facility in which the sorting activities are conducted. The first of these is the so-called vertical operation and the second is the horizontal-type operation.

Vertical Processing. Vertical handling and sorting of wastepaper traditionally, is conducted in multi-story facilities usually three levels high. The techniques, in general have changed very little over the past 40 or 50 years. Some reasonably large and successful paperstock packing plants have made no real basic changes in their facilities in several decades other than the installation of new elevators, materials handling equipment, or baling machines. It has been noted, however, that owners of such plants, up until recently could not clearly visualize any significant growth opportunities in their industry and were naturally reluctant to make the investment needed to expand.

In a typical three-story vertical paperstock packing plant, incoming bales, bags, or carts of potentially high-grade paperstock are first deposited on the third floor of the facility and segregated in terms of the general nature of the materials received. The bales are opened and banding materials are immediately cut up with special cutting equipment developed for the purpose, to prevent hazard to employees. Women workers, each assigned to work on a bale or other quantity of wastepaper at a time, then hand sort the components of the bale. The work area floor has, down its center, a line of 10 or more apertures. The workers throw the components of the particular grade of paperstock desired into the appropriate apertures in the floor. At the same time, they put the rejected materials into adjacent carts to be removed, subsequently, for further processing.

A section of the second floor of the building, directly under the section of the third floor described, vaguely resembles a narrow hall in a hotel lined with a series of doors closely spaced together. Each door leads to a room or closet fed by one of the apertures in the floor of the third level of the structure so that each closet, in effect, has an open "ceiling". The floor of the second floor hall is actually a conveyor belt leading to another large aperture in the "floor" at the end of the hall.

When a sufficient quantity of a desired grade of paperstock has been accumulated in each of the appropriate closets on the second floor of the plant, the appropriate doors are opened and accumulated materials are permitted to spill out onto the conveyor belt floor. The conveyor belt is then activated and the accumulated materials are moved to the aperture in the second floor hall and allowed to drop into the hopper for the baling machine located on the first floor of the structure.

Other processing operations are typically conducted on the second floor of the structure as well. One of these operations is cutting bindings from books and other publications with a guillotine cutter since these bindings often contain unrecycleable adhesives. Another is sawing cores of paper rolls to remove the valuable remaining yards of paper which remain on such rolls. The first floor of the structure, in addition to serving as the site for the baling machine, is also used to house the necessary outgoing shipment activities or administrative offices.

Horizontal Processing. The typical horizontal paperstock processing facility is a large one-story structure, which, in a warm climate such as in Florida, may have one or more open walls. The facility may even be an extension

of uncovered yard areas in which some basic sorting and storage activities are conducted.

The designation "horizontal" in this sense does not necessarily apply to the type of baling practiced in a particular plant. Like a vertical operation, a horizontal operation may include the use of both vertical and horizontal baling equipment. The key characteristic of the horizontal paperstock processing operation is the fact that materials are moved by carts or conveyors horizontally through the plant rather than by the use of gravity and elevators as in a vertical processing operation.

In a typical horizontal operation, incoming deliveries of bales, bags, or carts of wastepaper are received at the extreme end of the facility. Appropriate amounts of wastepaper are then assigned to individual workers, operating independently who break the bands and proceed to paw through the resulting pile, pulling out undesirable material to be rejected. Both the rejects and the components of desired paperstock grades are then placed in rolling carts. The carts containing the desired wastepaper are then moved along with carts collected from other workers to the baling operations. The carts containing the rejected materials may be set aside for further sorting or stored for subsequent baling, with other materials collected, as lower grades of paperstock. The filled carts removed from the sorting areas are quickly replaced with empty carts so that sorting operations may continue without interruption.

It is difficult to determine which of the two operations -- vertical or horizontal -- is the most economically desirable in the long run. A number of factors dictate the selection of the type of operation under different circumstances. Obviously, a horizontal operation calls for a greater use of

land and may be entirely practical where land is both available and cheap and relatively close to both wastepaper generators and paperstock users. In congested metropolitan areas, the vertical type operation is the only practical answer. Some operators of old vertical facilities periodically consider the merits of abandoning present facilities and constructing new horizontal facilities in outlying areas. However, for the most part, it is difficult in the eyes of these operators to justify the necessary investment required for such moves.

Combination Operations. The preceding discussions of vertical and horizontal sorting or processing operations focus, for the most part, on the sorting of high grade deinking paperstock and high grade pulp substitutes for which quality standards are most high. Many paperstock dealer/processors operate both vertical and horizontal facilities but handle the bulk or lowest value grades (news, mixed, old corrugated) on a strictly horizontal basis. Clearly, the need for careful hand sorting of these grades of paperstock is not as critical as it is for the high grades. Yet, it is urgent that certain types of contaminants be removed before even the cheapest grades of paperstock can be marketed.

One interesting example of a decontamination procedure of this type is that conducted by a large wastepaper collector whose trucks carry much of downtown Manhattan's office trash to the company's processing plant in Jersey City, New Jersey.* Here, sorting is important and the company shreds and bales wastepaper for reuse by manufacturers of roofing shingles, tar paper, chip board, etc. Pieces of metal would damage the shredder, a key component of the plant. Hand sorting proved slow and costly.

* Waste Trade Journal, October 31, 1970, p 9.

The company installed a 72-inch wide self-cleaning magnetic device to separate tramp iron from the mixed paper. About 75 percent of the weight of the metal removed by the magnet is made up of soft drink cans. Paper clips, baling wire -- even an occasional piece of angle iron -- and other miscellaneous scrap are among the remaining 25 percent.

The magnet is mounted about 27 inches above a conveyor that feeds the shredder. The conveyor is one of three that carries wastepaper from the trash truck to the baler. By the time the waste reaches the magnet, its depth has been reduced from 5 feet to about 2 feet. About 700 pounds per minute -- 70 cubic feet -- ride under the magnet. A day's load averages 300 tons and the plant operates 6 days a week.

Shredding and Hogging

The point has already been made in preceding sections of this report that in order to transport paperstock most economically, the commodity must be as tightly packed as possible. Shredding or hogging of paperstock is the means most often employed to achieve this objective. The functions may be accomplished at either the generator or processor level. The equipment involved, however, is costly both to buy and to maintain so investments can only be justified on the basis of economies in shipment or increased revenues. Some large generators such as paper converting plants and retail organizations have already installed such equipment but most of it is found at the dealer/processor level.

Shredding and hogging equipment may be used in conjunction with both low grades and high grades of paperstock. A facility described earlier is used entirely for low

grades -- corrugated and news. Similar facilities, however, at other processing plants are used alternately for both low grades and high grades.

In at least one plant, an air conveyor system and the equipment served by it are compactly housed in a new one-story 12,000 square foot structure separated from the original three-floor building which, by comparison has about 110,000 square feet of operating space. An additional 5,000 square feet concrete slab provides a stock receiving surface for the new facility. Incoming low grades are moved by front end loader to either of two Mayfran conveyors -- a 72 inch by 45 foot unit feeding old corrugated and scrap rolls to the hogger, and a 30 inch by 30 foot unit for materials not to be hogged, such as news and ledger, which go directly to the fan.

One effect of this distinction is to improve efficiency of the baler, by approximately equalizing the density of hogged corrugated and of fan shredded news. Thus, hogged corrugated weighs about 2 pounds per cubic foot, while hogged news is reduced to only about a half pound. However, fan shredded news remains at about 1-1/2 pounds. Since the baler is a fixed stroked machine at fixed time per stroke, it follows that the greater the density of material received, the fewer strokes, and less time required to compact it into bales. For specific figures, in this case, it is found that if the American Baler Company, Model No. 12849 unit requires, say, 20 strokes to produce its 30 by 40 by 72 inch bale from hogged corrugated, it will need no more than perhaps 22 strokes to produce a bale from shredded news, as compared with possibly 50 strokes for hogged news.

Heavier materials must still be hogged. The equipment at Buffalo is a Logemann No. 4872-CF heavy duty unit with 72 inch infeed throat and 2000 horse power drive. This power, and a 48 inch hammer swing, provide for all contingencies of breaking up such heavy materials as butt rolls at a constant production rate.

Baling of Wastepaper and Paperstock

Like shredding and hogging equipment, wastepaper baling equipment is used at both the generator and processor levels. However, there is a much greater usage of baling equipment than hogging and shredding equipment at the generator level..

In general, there are two basic forms of baling equipment -- the vertical stroke type baler and the horizontal type baler. Both have their advantages and are preferred by some users. More details on the characteristics of and trends in preferences for different types of baling equipment are included in the general report in this series. In general, however, it may be noted that the larger and the more complex a particular piece of baling equipment is, the greater is the demand upon the user to have employees knowledgeable in the basics of hydraulics and the greater the need to provide the necessary maintenance.

The range of costs and capabilities in baling equipment is quite wide. A relatively small and uncomplicated unit for use by a small generator of wastepaper might cost as little as \$1,000. On the other hand, a large and sophisticated piece of equipment such as that used in a modern paperstock packing plant might cost as much as a quarter of a million dollars.

Reportedly, the highest density paperstock baler used in the United States was installed at the Gardena California plant of Pioneer Paperstock Company, Division of Container Corporation of America (MARCOR). This baler, popularly known as "the monster" was built by Logemann for Pioneer at a cost of about \$100,000 15 years ago. While it is said to be unlikely that this piece of equipment would ever be duplicated, the estimated present cost, today, would be in the range of \$300,000 to \$400,000.

The "monster" at one time baled paperstock to a density of 48 to 49 pounds per cubic foot. Baling to this degree of compaction called for 1-1/4 inch strapping since using any narrower width of strapping might, hazardously, result in broken bales. Baling is now at a density of about 30 to 35 pounds per cubic foot on this particular piece of equipment.

This degree of compaction, however, is still well above the average in the industry. High density bales are generally packed to average about 25 pounds per cubic foot and the more typical pack is in the range of 17 to 18 pounds per cubic foot.*

Characteristics of Dealer/Processors

The set of nine statistical tables following represents the results of the tabulations of industry responses to the extensive survey questionnaires employed in the industry census conducted by NASMI during the summer of 1970. Overall census results are included in the general report in this series and data on characteristics of respondents concerned with other commodities are included in the other commodity reports.

* The Future of Secondary Fibers in Paper Mills, O. T. Reeves, Container Corporation of America, American Paper Industry magazine, May, 1970.

The paper section of the questionnaire employed was somewhat more detailed than sections dealing with other commodities. Consequently, more data are presented on characteristics of processors and dealers concerned with paper than those concerned with other commodities. Further, potentially more data can be made available through cross tabulation of results.

A total of 173 census respondents confirmed that they do handle wastepaper in some form. Table 7 shows that 96 of the respondents, or 55 percent of the total number handling wastepaper, reported obtaining at least some of their wastepaper from manufacturing, converting, and printing plants, etc. Forty-seven respondents, or 27 percent of the total number, reported obtaining over half of their wastepaper from manufacturing, converting, and printing plants. Eighty-three of the respondents, or 48 percent of all of the respondents handling paper, reported obtaining at least some of their paper from collector/dealer sources. Nineteen respondents, or 11 percent of the total, reported obtaining over half of their wastepaper from collector/dealer sources. The number of respondents who reported obtaining wastepaper from other sources is also shown in Table 7.

Table 8 shows that of the 76 respondents obtaining some of their wastepaper from organizational and institutional sources including paper drives, about 24 percent of these respondents obtained over half of their wastepaper from such sources. Of 24 respondents obtaining some portion of their wastepaper from municipal wastes, about 25 percent obtained over half of their wastepaper from municipal waste sources.

Table 9 shows that of 109 survey respondents, about 11 percent purchased 200,000 tons or more of wastepaper and paperstock in 1969 including paper handled only on a brokerage or agent basis and accounted for an estimated 50 percent of the total purchases by all respondents. Care must be exercised in interpreting the purchase tonnage estimates in this table because of "double counting" that results

TABLE 7. DISTRIBUTION OF RESPONDENTS PURCHASING WASTE PAPER
FROM VARIOUS SOURCES(a)

Source	Number of Respondents Obtaining Following Proportions of Waste Paper Purchases from Indicated Sources				Total
	1-25	26-50	51-75	75+	
	Percent	Percent	Percent	Percent	
Industrial and commercial sources					
Manufacturing, converting, and Printing plants, etc.	34	15	17	30	96
Office buildings	34	1	0	0	35
Supermarkets, Department stores, and other retail outlets	44	8	2	1	55
Collector/dealer sources	42	22	4	15	83
Over-the-scale sources (including Institutions, where applicable)	42	13	3	8	66
Other	7	--	--	--	7
Total number of respondents					173

(a) Requested information: "Indicate the approximate percentage of waste paper your company purchased from each of the following sources in 1969 (whether or not the paper was physically handled through your plant or plants)."

Source: Extensive Survey of Paperstock Industry and Other Secondary Materials Industries, conducted by NASMI, 1970.

TABLE 8. DISTRIBUTION OF RESPONDENTS PURCHASING WASTE PAPER FROM ORGANIZATIONAL AND INSTITUTIONAL SOURCES INCLUDING PAPER DRIVES AND FROM MUNICIPAL WASTE SOURCES (a)

Source	Number of Respondents Obtaining Following Proportions of Waste Paper Purchases From Indicated Sources				Total
	1-25 Percent	26-50 Percent	51-75 Percent	75+ Percent	
Organizational and institutional sources including paper drives	51	7	5	13	76
Municipal waste	14	4	2	4	24
Total number of respondents					173

(a) Requested information: "Estimate the percentage of the above waste paper that came from the following."

Source: Extensive Survey of Paperstock Industry and Other Secondary Materials Industries, conducted by NASMI, 1970.

TABLE 9. DISTRIBUTION OF RESPONDENTS BY THE TOTAL TONNAGE OF WASTE PAPER AND PAPERSTOCK PURCHASED IN 1969 (INCLUDING PAPER HANDLED ON BROKERAGE OR AGENT BASIS--WHETHER OR NOT IT PHYSICALLY MOVED THROUGH PLANTS) BY RESPONDENTS; ESTIMATED PURCHASES OF RESPONDENTS IN EACH SIZE CATEGORY

Size Category (Range of Tonnage)	Number of Respondents (a)	Estimated Purchases of All Respondents in Size Category, tons (b)	Share of Total Estimated Purchases Handled by Respondents in Size Category, percent (c)
0 - 25,000 net tons	30	375,000	4
25,000 - 50,000	31	1,162,000	12
50,000 - 75,000	16	1,000,000	11
75,000 - 100,000	8	700,000	7
100,000 - 125,000	7	788,000	8
125,000 - 150,000	2	275,000	3
150,000 - 175,000	2	325,000	3
175,000 - 200,000	1	188,000	2
200,000 and over	12	4,700,000	50
TOTAL	109	9,513,000	100

Sources: (a) Extensive Survey of Paperstock Industry and Other Secondary Materials Industries, conducted by NASMI, 1970.

(b) Estimated by assuming that the midpoint of each size category represents average tonnage purchased by all respondents in the size category; tonnage for 200,000 and over category estimated based on information from field calls, etc. (Some double counting of tonnages may exist in these estimates because of wastepaper and paperstock that passed through more than one dealer or processor in its route from generator to user.)

(c) Calculated using estimates indicated in (b).

if the same wastepaper or paperstock passes through more than one dealer or processor in moving from generator to user.

Table 10 combines survey responses and estimates from Table 9 to estimate tonnage physically handled by the respondents. On the basis of this information, it is estimated that about 45 percent of the total purchases by respondents is physically handled through their plants.

Table 11 shows that of 91 respondents, about 28 percent could have physically handled no more than 10,000 tons of paperstock through their plants in 1969 with the facilities they had at that time, while another 28 percent could have handled over 50,000 tons of paperstock.

Table 12 shows that of 99 survey respondents, only about 18 percent operated their plants less than 41 hours per week in 1969 and more than 42 percent operated their plants in excess of 45 hours per week in 1969.

Three additional tables provided are based either on a cross-tabulation of survey statistics from the paper section of the census form or upon basic data in the general portion of the census form.

Table 13 shows the average or arithmetic mean tonnage of wastepaper and paperstock purchased by census respondents in each of the 9 geographical census regions. For example, the average purchases of 35 respondents in the East North Central region in 1969 was 67,500 tons of wastepaper and paperstock.

Tables 14 and 15, respectively, show the ranges of total value of plant and equipment for handling all secondary materials and 1969 gross sales of all secondary materials for those survey respondents who confirmed that they handled paper.

TABLE 10. AVERAGE PERCENTAGE OF TOTAL PURCHASES PHYSICALLY HANDLED AND ESTIMATED TONNAGE PHYSICALLY HANDLED BY RESPONDENTS IN EACH SIZE CATEGORY

Size Category (Range of Tonnage)	Number of Respondents (a)	Average Percentage of Total Purchases Physically Handled Through Plants by Respondents in Size Category (b)	Estimated Purchases Physically Handled Through Plants by All Respondents in Size Category, tons (c)
0 - 25,000 net tons	30	73	275,000
25,000 - 50,000	31	53	615,000
50,000 - 75,000	16	52	513,000
75,000 - 100,000	8	64	449,000
100,000 - 125,000	7	49	384,000
125,000 - 150,000	2	10	28,000
150,000 - 175,000	2	35	114,000
175,000 - 200,000	1	25	47,000
200,000 and over	12	42	1,960,000
Total	109	46	4,385,000

Sources:

(a) Table 9.

(b) Calculated from responses to Extensive Survey of Paperstock Industry and Other Secondary Materials Industries, conducted by NASMI, 1970, giving equal weight to each respondent in the size category. The 46 percent figure for all respondents was calculated using total estimated purchases and total estimated purchases physically handled by all respondents.

(c) Calculated by applying average percentage of purchases physically handled to the total estimated purchases (from Table 9) for each size category. (Some double counting of tonnages may exist in these figures because of wastepaper and paperstock that passed through more than one dealer or processor in its route from generator to user.)

TABLE 11. DISTRIBUTION OF RESPONDENTS BY THE MAXIMUM TONNAGE OF PAPERSTOCK THEY COULD HAVE PHYSICALLY HANDLED THROUGH THEIR PLANTS IN 1969 WITH THE FACILITIES THEY HAD AT THAT TIME.

Range of Tonnage	Number of Respondents	Percent of Total
0 - 6,000 net tons	21	23.1
6,000 - 10,000	4	4.4
10,000 - 15,000	6	6.6
15,000 - 20,000	6	6.6
20,000 - 25,000	9	9.9
25,000 - 35,000	9	9.9
35,000 - 50,000	11	12.1
Over 50,000	25	27.5
Total	91	100.0

Source: Extensive Survey of Paperstock Industry and Other Secondary Materials Industries, conducted by NASMI, 1970.

TABLE 12. DISTRIBUTION OF RESPONDENTS BY NUMBER OF HOURS PER WEEK
THEY OPERATED THEIR PLANTS ON THE AVERAGE IN 1969.

Range of Number of Hours Per Week Plants Were Operated	Number of Respondents	Percent of Total
Less than 35	3	3.0
36 to 40	15	15.2
41 to 45	38	38.4
Over 45	42	42.4
Total	99	100.0

Source: Extensive Survey of Paperstock Industry and Other Secondary Materials Industries, conducted by NASMI, 1970.

TABLE 13. ARITHMETIC MEAN TONNAGE OF WASTE PAPER AND PAPERSTOCK
PURCHASED BY RESPONDENTS IN VARIOUS GEOGRAPHIC REGIONS

Region in Which Business Was Conducted	Number of Respondents	Mean Quantity Per Respondent, tons
New England	10	50,000.0
Middle Atlantic	27	71,759.3
South Atlantic	13	45,192.3
East North Central	35	67,500.0
East South Central	5	57,500.0
West North Central	5	87,500.0
West South Central	4	50,000.0
Mountain	1	112,500.0
Pacific	11	92,045.5
Outside United States	0	0.0

Source: Extensive Survey of Paperstock Industry and Other Secondary Materials
Industries, conducted by NASMI, 1970.

TABLE 14. DISTRIBUTION OF RESPONDENTS BASED ON TOTAL VALUE OF
PLANT AND EQUIPMENT FOR HANDLING ALL SECONDARY MATERIALS.

Total Value of Plants and Equipment Handling Paper (thousand dollars)	Number of Respondents	Percent of Total Respondents
1 - 250	42	34.1
251 - 500	29	23.6
501 - 1000	25	20.3
1001 - 2000	15	12.2
2001 - 7000	10	8.1
7001 - 10,000	1	0.8
More than 10,000	1	0.8
Total handling paper	123	100.0

Source: Extensive Survey of Paperstock Industry and Other Secondary Materials Industries, conducted by NASMI, 1970.

TABLE 15. DISTRIBUTION OF RESPONDENTS BASED ON 1969 GROSS SALES OF ALL SECONDARY MATERIALS HANDLED.

Total 1969 Gross Sales by Millions of Dollars	Number of Respondents	Percent of Total Respondents
Under 1	36	23.8
1 - 3	59	39.1
3 - 5	21	13.9
5 - 8	12	7.9
8 - 12	12	7.9
12 - 20	5	3.3
20 - 30	3	2.0
30 - 50	3	2.0
Over 50	0	0.0
Total handling paper	151	100.0

Source: Extensive Survey of Paperstock Industry and Other Secondary Materials Industries, conducted by NASMI, 1970.

USES AND MARKETS FOR
PAPERSTOCK AND WOOD PULP

As background for this section, Tables 16 and 17 show trends for the past decade in paperstock movement and stocks and in paperstock consumption compared with consumption of other fibrous materials in paper and paperboard productions.

Any discussion of markets for paperstock and wood pulp and the competition between these two commodities in these markets is complicated by the fact that there are so many different grades of paperstock. Some of these are substitutable for wood pulp in certain applications and some are not. Further, there are some end uses for paperstock in which it would be completely uneconomic to use wood pulp as substitutes. Perhaps the most defensible generalization which can be made is that paperstock, for the most part, is employed as a raw material in the production of bending boxboard, while wood pulp is used as a raw material principally for paper and other categories of paperboard. Tables 18 and 19 identify known end uses for paperstock and trends in paperstock consumption.

In the following sections of this report, the various categories of paper and paperboard in which paperstock and wood pulp are used at the present time are defined and discussed. The problems and constraints which have, thus far, tended to limit the use of paperstock to the production of certain categories of paper and paperboard are reviewed in a succeeding section in this report.

Paperboard

By definition, paperboard is one of the two broad subdivisions of the paper industry, the other being paper. Paperboard and paper differ in weight,

TABLE 16. TRENDS IN PAPERSTOCK MOVEMENTS AND STOCKS (Short tons)

Year	Mill Inventories	Mill Consumption	Inventory	Imports	Exports
1959	9,267,000	9,414,000	617,000	72,500	127,700
1960	8,965,000	9,021,000	561,000	67,500	153,200
1961	9,027,000	9,018,000	570,000	62,500	215,200
1962	9,076,000	9,075,000	571,000	66,600	209,500
1963	9,640,000	9,551,000	598,000	55,187	229,641
1964	9,490,000	9,493,000	596,000	78,446	250,536
1965	9,907,000	9,935,000	568,000	98,075	265,763
1966	10,712,000	10,541,000	674,000	117,000	245,000
1967	9,944,000	9,888,000	826,000	145,268	239,167
1968	10,362,000	10,286,000	583,000	107,578	242,688
1969	10,478,000	10,446,000	608,000	93,099	288,819

Source: Paperboard Packaging magazine, August, 1970, p. 50 (Based on Bureau of Census Reports).

TABLE 17. TRENDS IN PAPERSTOCK CONSUMPTION COMPARED WITH CONSUMPTION
OF TOTAL FIBROUS MATERIALS IN PAPER AND PAPERBOARD PRODUCTION
(Thousands of Short Tons)

Year	Woodpulp	Paperstock	Other Materials	Total	Paperstock Percentage of Total
1959	25,189	9,414	979	35,582	26.4
1963	30,220	9,551	1,285	41,056	23.2
1964	32,031	9,493	954	42,478	22.3
1965	34,143	9,935	1,003	45,077	22.0
1966	36,649	10,451	1,054	47,664	21.3
1967	36,015	9,888	914	46,683	20.9
1968	40,813	10,286	907	52,006	19.7
1969	43,400	10,446	894	54,740	19.0

Source: Paperboard Packaging magazine, August, 1970, p. 51 (Based of Bureau of Census Reports).

TABLE 18. U. S. CONSUMPTION OF PAPERSTOCK BY KNOWN END USES BY CATEGORIES OR GRADES - 1969 (Thousands of short tons)

Category or Grade	End-Use				Total	Percent of Total
	Paperboard	Construction Paper and Board Including Gypsum Wallboard	News Print	Fine Paper		
Mixed paper	1,835	1,000	---	---	2,835	24.8
Old corrugated	3,468	400	---	---	3,868	33.9
News	1,455	600	360	---	2,415	21.1
High grades	1,291	---	---	1,000	2,291	20.2
Total	8,049	2,000	360	1,000	11,409	---
Percent of Total	70.5	17.5	3.2	8.8	---	100.0

Source: Unpublished estimates from Paperstock Conservation Committee, American Paper Institute.

TABLE 19. TRENDS IN CONSUMPTION OF PAPERSTOCK BY KNOWN END-USES
(Thousands of short tons)

Year	Paperboard Including Wet Machine Quantity	Percent of Total	Paper Including Newsprint Quantity	Percent of Total	Construction		Percent of Total	Pulp Mills	Percent of Total	Total Quantity	Percent
					Paper and Paperboard Quantity	Paperboard Quantity					
1963	7544.6	78	1198.0	13	842.7	9	27.5	---	---	9612.8	100
1964	7499.4	79	1177.1	13	787.4	8	29.1	---	---	9493.0	100
1965	7523.0	76	1498.3	15	814.0	8	n.a.	---	---	9935.3	100
1966	7690.0	76	1534.4	15	934.6	9	n.a.	---	---	10,159.0	100
1967	7821.5	77	1403.7	14	870.1	9	29.7	---	---	10,125.0	100
1968	8009.8	77	1429.9	14	891.2	9	31.1	---	---	10,362.0	100
1969	8009.5	77	1445.9	14	901.2	9	31.4	---	---	10,478.0	100

Source: Census of Manufactures. Reconciliations by Paperboard Packaging magazine, August, 1970, p. 50.

thickness, and rigidity. Paperboard is generally at least 0.012 inch thick and is heavier and more rigid than paper. There are, however, some exceptions to this rule. Blotting paper, felts, and drawing paper in excess of 12 points* are classified as paper while corrugating medium, chip board and liner board less than 12 points, are classified as paperboard. The general public tends to employ the term "cardboard" as the designation for paperboard or any fibrous material stiffer and heavier than paper, but this is a misnomer since cardboard, within the industry, actually is a particular grade of paperboard.

The major categories of paperboard are designated as containerboard and boxboard. The former includes those grades principally used in the manufacture of corrugated shipping containers (also called corrugated boxes) while the latter represents the grades used for fabricating folding or setup boxes. The nomenclature for these end products of paperboard is somewhat confusing and tends to vary geographically and even within companies in the industry. It has been recommended but not generally accepted that the term "box" should be used exclusively to designate solid fiber or corrugated shipping containers while the designation "carton" should be applied to the interior package, commonly used to enclose soap powder, cereals, cigarettes, and similar products.

Containerboard

Containerboard is by far the largest category of paperboard. Table 20 shows that in 1969 containerboard accounted for approximately 68 percent of total U. S. paperboard production. As a general class of material, containerboard may be either solid fiber or corrugated combined board used in the manufacture

* Thousandths of an inch.

TABLE 20. COMBINATION PAPERBOARD AND SOLID WOODPULP BOARD
PRODUCTION BY TYPE (Thousands of tons)

Type	1969 Tonnage	Percent of Total Paperboard Production	Percent of Sub-Total
Containerboard Type	17,829	67.6	100.0
Combination	2,567	9.7	14.5
Solid	15,262	57.9	85.5
Boxboard Type	8,548	32.4	100.0
Combination	4,755	18.0	55.5
Solid	3,793	14.4	44.5
Total Paperboard	26,378	100.0	
Combination	7,323	27.8	
Solid	19,055	72.2	

Source: Paperboard Industry Statistics - 1969, American Paper Institute,
Paperboard Group, p. 9.

of shipping containers. Corrugated combined board consists of two layers of linerboard with a fluted sheet of corrugating medium glued in between. The designation also includes minimal amounts of chip and filler board used to increase bulk and rigidity.

At the present time, relatively little paperstock is used in the production of containerboard. More than 85 percent of the total containerboard produced in 1969 was designated as "solid", (in a different sense than "solid" as contrasted to corrugated board) because it contained less than 15 percent of secondary fibers. The relatively small amount of paperstock used as raw material in the production of containerboard was used almost entirely in the corrugating medium and chip and filler components of containerboard and to an insignificant degree in liner board.

The general grade of paperstock used in the production of containerboard is designated as "corrugated" and consists of old corrugated shipping containers recovered from industrial generators and corrugated clippings generated in corrugated box plants. The paperstock is mechanically disintegrated in water to provide a pulp suspension. The stock is further processed to remove foreign materials but is not deinked. Various efforts have been made to promote the use of greater quantities of paperstock in containerboard, and, in view of present pressures and interests in solid waste utilization, these efforts undoubtedly could be increased in the future. The Herty Foundation has developed samples of containerboards, containing as much as 50 percent of reclaimed fiber from old corrugated containers, with structural and appearance properties almost indistinguishable from those of 100 percent virgin kraft pulp.

Recently, Crown Zellerbach Corporation established a new secondary fiber system at Antioch, California, constructed adjacent to Crown's existing paper mill and converting operation and equipped to supply 200 tons a day of secondary fiber pulp primarily from reclaimed corrugated boxes, for remanufacture into liner board.* All systems, including pulping, cleaning, pumping, and purification are designed to be expanded to 300 tons per day with minimum modification of the basic plant.

Among the major producers of containerboard in the United States are such firms as International Paper Company, St. Regis, Container Corporation (MARCOR), Continental Can Company and Westvaco. All of these firms, in addition to other producers of containerboard, have vast forest holdings. Their pulp mills are located close to both their forest resources and their paperboard mills in southeastern and northwestern United States. This is apparent in Table 22. The virgin wood pulp is moved directly from the adjacent pulp mills to the high-speed and efficient fourdrinier machines in the board mills which produce the bulk of containerboard consumed. Then, the containerboard is shipped in roll form to converting plants for fabrication into either solid fiber or corrugated shipping containers. Containerboard, of course, is available in a variety of weights or "tests" to fit the specifications for the end products.

Boxboard

Boxboard is the other general category of paperboard. As Table 20 shows, boxboard accounted for approximately 32 percent of total U. S. paperboard production in 1969. The three general classifications of boxboard are folding

* Pulp and Paper magazine, December, 1970, p 112.

boxboard, set-up boxboard, and that used for milk cartons and food service. More than half of the total boxboard produced in 1969 is classified as combination type or made primarily from paperstock. The remainder is categorized as "solid" or produced from virgin wood pulp.

Table 21 shows that of the three categories of boxboard, folding boxboard accounts for the bulk of the paperstock consumed. Only negligible amounts of paperstock are employed in the production of food service grades. Set-up boxboard production is relatively small, accounting for only about 2 percent of total paperboard production in 1969. Yet all set-up boxboard produced is classified as combination board made from paperstock.

The grades of boxboard used in the fabrication of milk cartons, frozen food containers and the like are all produced entirely from virgin sulphate pulps and are made on the fourdrinier machine.

Folding boxboard, produced from paperstock, is, for the most part, made on the cylinder board machine. The board is produced in layers or plies of varying composition. For example, the top ply or liner, which becomes the outer or printed surface of the folding carton, is most often a layer of the highest quality material. The bottom liner, which becomes the inside of the folding carton, may be a less expensive grade and also may have any of several functional properties. Finally, the filler or center sections are usually reworked fibers.

In the cylinder board manufacturing process, prepared pulp, looking like lumpy oatmeal, is pumped into vats where formulation of the boxboard takes place as a cylinder of fine wire mesh rotates and picks up the fibers and transfers them to a moving flat felt belt, thus forming a continuous web

TABLE 21. PAPERBOARD PRODUCTION BY TYPE AND GRADE

		1969 Tonnage	Percent of Total Paperboard	
CONTAINERBOARD - DOMESTIC USE				
Linerboard		9,699	14,397	54.6
Combination	347			
Solid	9,352			36.8
			1.3	
			35.5	
Corrugating materials		4,393		16.7
Combination	777			
Solid	3,615			
			2.9	
			13.8	
Chip and filler		305		1.1
Combination	280			
Solid	25			
			1.1	
			--	
BOXBOARD - DOMESTIC USE				
Folding		4,262	6,424	24.4
Combination	2,629			
Solid	1,633			16.2
			10.0	
			6.2	
Set-up		497		1.9
Combination	497			
Solid	--			
			1.9	
			--	
Milkcarton & food service		1,665		6.3
Combination	40			
Solid	1,624			
			0.1	
			6.2	
ALL OTHER (including export)				
Containerboard		3,432	5,557	21.0
Combination	1,162			
Solid	2,269			13.0
				4.4
				8.6

TABLE 21. PAPERBOARD PRODUCTION BY TYPE AND GRADE (Continued)

	1969 Tonnage	Percent of Total Paperboard
Boxboard		
Combination	2,125	8.0
Solid	1,589 536	6.0 2.0
TOTAL PAPERBOARD	<u>26,378</u>	<u>100.0</u>

Source: Paperboard Industry Statistics - 1969, American Paper Institute,
Paperboard Group, p. 10-11.

of paperboard as it comes off the machine. The cylinder machine can produce board with as many different layers as there are cylinders, perhaps 5 to 8 in number.

After enough water has been extracted from the web so that it can support itself, it travels through a series of steam-heated drying rolls and the layers are combined by pressure. The pulp, which started into the machine as 95 percent water, emerges as boxboard with a moisture content of about 5 percent.

The types of folding boxboard most commonly used for making folding cartons are discussed below in approximately ascending value order along with other pertinent information.*

Chip Boards. This classification includes semi-bending chip, bending chip and news vat lined chip. These grades are used for the lower grades of folding cartons, gift boxes and general purposes.

Manila and Mist Boards. This classification of boxboards includes those used largely for making suit boxes such as are supplied in department stores for packaging and wearing apparel, and for other forms of folding cartons in which good bending qualities and a surface well adapted to printing in fancy colored designs are essential properties.

Patent Coated Board. Boxboard used for better grades of folding boxes is patent coated on one or both sides and made in many combinations, such as patent coated manila, patent coated newsboard, patent coated news, center manila back, etc. Each of these grades has its place in the folding box trade where cost, quality or appearance may dictate the grade.

* The Folding Carton, Paperboard Packaging Council, Washington, D. C., 1969.

Clay Coated Board. This is a high grade folding boxboard, coated with clay (by air knife, brush, machine, etc.) used in the manufacture of folding boxes. Distinguishing features are brightness of color, excellence of printing surface and permanence of color and brightness.

Cast Coated Board. This high grade folding boxboard has an exceptionally high gloss finish which is obtained by drying the coating of the web of board by applying it to a highly polished surface.

Laminated Board. Laminated board is made by combining two or more similar or dissimilar sheets by use of adhesives such as starch, resin, asphalt or other binder. Parchment paper to paperboard; glassine paper to boxboard; colored or patterned paper to boxboard; foil to boxboard; etc.

Solid Bleached Sulphate Board. This board is made entirely of virgin sulphate pulps and when suitably treated may be used for liquid, moist or oily foods; usually made on a fourdrinier machine, and frequently machine-clay coated.

Kraft (natural or bogus) Boards. Sulphate or kraft board, brown colored throughout, is used generally as a packaging medium for automotive parts, bolts, nuts, hardware, etc., where strength is required but eye appeal is not necessary. Bogus kraft is an adulterated board colored brown to look like kraft usually with an extra strength or kraft-like finish.

Virtually all of the grades of paperstock marketed are used in the production of folding boxboard. The designations for some of the grades of folding boxboard enumerated above, it may be noted, are derived from the types of paperstock employed. For example, news vat line chipped is a combination of chip news lined on one or both sides. Typically, the bulk grades of paperstock,

mixed, news, and old corrugated are used in the furnish for the bottom liner or the center for cylinder board. The high grades are used for the top ply or liner which becomes the outer printed surface of the box.

As Tables 22 and 23 show, most of the producers of boxboard made from paperstock are located in the northeast and north-central states relatively close to generators of wastepaper. Among the major producers of cylinder board made from paperstock are such firms as Container Corporation, Continental Can, Hoerner Waldorf, Whippany Paperboard, and Federal Paperboard Company, Inc., Producers of solid bleached sulphate board, the competing board made entirely of virgin sulphate pulps and produced on the fourdrinier machine are principally located in the southeast and northwest.

Other Paperboard

Paperstock is also utilized in the production of paperboard grades other than containerboard and boxboard. Among these are grades used for such end products as fiber cans, drums, tubes, cores, binder boards used in binding books, and shoe board used for shoe reinforcement and such parts as counters and innersoles. Other grades are used for coasters, electrical pressboard and trunk fiberboard. Finally, paperstock is used in the production of building or construction grades of paperboard such as those used as the outer liner for gypsum board.

For these end uses, the cheaper or bulk grades of paperstock are mainly used. In the production of roofing paper which might be included in the construction grades category, mixed papers and old corrugated are used to a substantial degree. While roofing paper is a highly utilitarian and unaesthetic

TABLE 22. PAPERBOARD PRODUCTION CAPACITY BY REGION AND TYPE - 1969

Region	Combination Paperboard		Solid Paperboard	
	Capacity, thousands of tons	Percent of Total	Capacity, thousands of tons	Percent of Total
Northeast	3,059	36.6	286	1.5
North Central	2,968	35.5	1,585	8.2
Southern	1,393	16.6	14,204	74.0
Pacific	946	11.3	3,123	16.3
Total	8,366	100.0	19,198	100.0

Source: Paperboard Industry Statistics - 1969, American Paper Institute, Paperboard Group, p. 4.

TABLE 23. PAPERSTOCK CONSUMPTION BY REGION - 1963

Region	Consumption by Indicated Users, thousands of tons			Regional Consumption As a Percent of Total
	Paper Mills	Paperboard Mills	Bldg. Paper and Board Mills	
Northeast	431	2,782	230	36.5
North Central	629	2,887	219	39.7
South	30	1,144	211	14.7
West	47	731	79	9.1
Total	1,137	7,544	739	-----
Percent of total	12.1	80.1	7.8	100.0

Source: Unpublished data, Bureau of the Census, U. S. Department of Commerce, 1963.

product, the raw materials which go into its production must still meet specific standards. Even though roofing paper, eventually saturated, is made from low grade paperstock, the presence of spots caused by contaminants in the web can reduce the value of a particular run of roofing paper or make it unsaleable. The spots can eventually become weak spots in the paper and result in a leaky roof. Further, these weak spots can cause costly and time consuming breaks in the paper web when it is being run on the paper machine.

Paper

The general category of paper represents the second of the two broad subdivisions of the paper industry, the other being paperboard. Compared with paperboard, the paper subdivision presently is a relatively small consumer of paperstock. In 1969, the paper subdivision, excluding construction papers, accounted for only 12 percent of paperstock consumed. (See Table 18).

Except for the old news consumed by news print deinking mills, all of the paperstock consumed by the paper subdivision is either high grade deinking paperstock or high grade pulp substitutes.

Newsprint

Newsprint is a low cost non-durable, light-weight paper made principally from mechanical pulps. Most newsprint is consumed in newspapers, although amounts are also used in such products as hand bills, shopping news, comic books, etc. Ground wood pulp, the principal furnish for newsprint, has a high lignin content which causes yellowing. Blue dyes are added to counteract the yellowing and give newsprint its grayish cast.

More than 75 percent of the domestic demand for newsprint is supplied by imports, mainly from Canada. The United States made newsprint duty free during the 1920's, and Canadian suppliers quickly dominated the U. S. market. U. S. manufacturers, however, including some major newspaper publishing organizations, own a substantial part of Canadian newsprint capacity. In recent years, there has been a substantial increase in U. S. newsprint capacity, particularly in the South.

Use of paperstock or specifically, old news, in the production of newsprint in the United States is a relatively new phenomenon over the past decade. From the standpoint, however, of minimizing the flow of wastes into solid waste channels and husbanding our natural resources, this phenomenon has been most interesting. At the present time, only one company, Garden State Paper Company, of Garfield, New Jersey, a subsidiary of Media General Corporation, has demonstrated success in deinking old news and producing newsprint from the secondary fibers thus reclaimed. Currently, Garden State has its main mill at the New Jersey headquarters location, a second mill in Pomona, California, and a third in Alsip, Illinois, near Chicago, operated as a venture with the Field organization. A fourth mill is now reportedly planned for construction in southwestern Ohio. Production at the three existing mills reportedly totaled about 360,000 tons in 1969, less than 5 percent of total newsprint consumed, but still representing a major factor in consumption of old news.

Precise details on the chemistry of Garden State's deinking process are not available for publication, but it is known that the process is economically feasible and techniques used for collection of the necessary raw materials have been successful.

Other Paper Grades

Paperstock is also used in the production of grades of paper other than newsprint. Recent statistics as to the amounts and types of paperstock used as raw material for these other specific grades of paper are unavailable or incomplete. However, it is known that substantial quantities of paperstock are consumed in the consumption of sanitary and tissue paper, printing papers, book paper, and fine paper, even though virgin wood pulp accounts for, by far, the greater share of fibrous raw materials consumed.

For the most part, the grades of paperstock used in the production of these other types of paper are the so-called high grades or least contaminated grades. As has been noted, the best or most valuable grades of paper are principally collected from generators of fairly homogenous cuttings or other forms of wastepaper such as ledger sheets and tabulation cards. Some of the paper mills who consume paperstock can use the incoming material as direct substitutes for virgin pulp almost as received from paperstock processors. A wrapping tissue mill, for example, may limit its paperstock consumption to side run rolls and tab cards with little or no ink on them. This paperstock is then used only in the furnish for the mill's second grade of wrapping tissue in which the presence of some ink contamination is allowable. For the best grade of white wrapping tissue, however, the mill would use virgin fibers exclusively.

An increasing number of paper mills, over the past decade, has been installing costly but highly effective deinking equipment, making it possible for the mills to use paperstock in the production of paper grades comparable in quality to those made exclusively with virgin fibers. Firms which have

installed such equipment include some that are integrated with virgin pulp producing mills and others who purchase virgin pulp on the open market. It is estimated that the present capacity of paper mills producing office, printing, offset, and related grades of paper from recycled material exceeds 500,000 tons annually. Such companies as St. Regis Paper Company, Kimberly-Clark, Tileston and Hollingsworth (Diamond International Corp.), Bergstrom Paper Company, Oxford Paper Company, Allied Paper Mills (division of SCM), Georgia-Pacific Company, Newton Falls Paper Mill (McCall's publications), are representative of the firms having substantial productive capacity.*

Other Uses and Markets for Paperstock

In addition to paperboard and paper, paperstock is used as raw material in the production of a number of other products. Among these are molded products such as egg cartons, flower pots, and funeral wreath holders and a variety of construction products such as soil pipe and insulation materials. Statistics are unavailable as to the amounts of paperstock consumed in these end uses but the quantities are believed to be nominal in comparison with the total volume of wastepaper generated. Interestingly, however, it is known that most of the paperstock consumed in the production of these products is in the form of the low grades or bulk grades of mixed papers, news and old corrugated which contribute most to the solid waste problem.

One particularly interesting end-use in this broad area is a reportedly "highly effective cellulosic-type building insulation manufactured from 100 percent recycled paper". The manufacturing process for cellulose insulation

* Memorandum to Alvin R. Alm, Council on Environmental Quality from M. J. Mighdoll, Executive Vice President, NASMI, dated December 4, 1970.

consists of processing the cellulosic materials into a fibrous form and results in a product that is retardant to fire, decay, and vermin, is non-irritating, and non-corrosive. Cellulose, a loose fill insulation, can be installed above ceilings and under floors or be injected into wall cavities through openings as small as 3/4 of an inch. Cellulose insulation is currently being used in new and existing residential structures including mobile and modular homes. It is also used in limited industrial applications. A new spray-on application makes cellulose insulation more adaptable to commercial structures. In 1969, approximately 50,000 homes and apartment units were insulated with cellulose insulation.*

Except for the higher grades of molded pulp products used in food packaging applications, these additional nonpaper and nonpaper board applications for paperstock do not consume virgin wood pulp. The relatively high cost of virgin wood pulp makes its use prohibitive in these applications, so paperstock is the only feasible alternative in the production of these highly utilitarian and nonaesthetic products.

* National Cellulose Insulation Manufacturers Association, Lima, Ohio, 45802.

FACTORS CONSTRAINING INCREASED RECYCLING
OF PAPERSTOCK

During the course of the literature search and intensive interviewing phases of the study, a great many problems or factors constraining the recycling of paper were identified. (Table 24 demonstrates the decline in paper recycling as a percentage of total paper and paperboard consumption over the past decade.) Some of these factors have had and will continue to have impact upon the attitudes, plans, and actions of only one link in the chain of distribution of paperstock -- generator, dealer/processor, user -- while others impact on all of the links and the interfaces between them as well. In the following sections of this report, these problems and factors constraining recycling are discussed individually. The distribution links on which each of the factors has impact are identified, and the nature of these impacts are reviewed. The order of discussion is as follows:

- General problems or factors broadly constraining recycling
- Factors influencing actions of generators
- Factors influencing actions of collectors, dealers, and processors
- Factors influencing actions of paperstock users.

All of these factors have tended in the past, either directly or indirectly, to increase the flow of wastepaper into solid waste channels. This increased flow, of course, has added to the tangible and intangible costs to society of disposing of all wastes.

TABLE 24. PAPERSTOCK CONSUMPTION COMPARED WITH PAPER AND PAPERBOARD CONSUMPTION

Year	Paper and Paperboard Consumption, thousands of tons	Paperstock Consumption, thousands of tons	Recycling Ratio, percent
1959	38,820	9,267	23.9
1960	39,227	8,965	22.4
1961	40,406	9,027	22.4
1962	42,208	9,076	21.5
1963	43,406	9,640	22.2
1964	45,968	9,490	20.5
1965	48,762	9,907	20.3
1966	52,790	10,712	20.2
1967	51,996	9,944	19.1
1968	53,812	10,362	19.2
1969	58,300	10,478	17.9

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Source: Paperboard Packaging Magazine, August, 1970. Based on Bureau of Census Reports, and PSIA data, p. 49.

General Problems or Factors
Broadly Constraining Recycling

The problems and factors enumerated below tend to impact on the attitudes, plans, and actions of all links in the chain of distribution of paperstock from source to end user.

Relatively Declining Demand for Combination Paperboard

Without question, the factor which, in the recent past, has been the major obstacle to efforts to increase recycling has been the relative decline in demand for and production of paperboard made at least in part from recycled fibers. This relative decline is demonstrated most dramatically in Table 25. It may be noted that total paperboard production over the period from 1960 to 1969 increased about 10.5 million tons or 65.6 percent. Of this total production, solid paperboard, containing 85 percent or more virgin wood pulp, increased 9.9 million tons or 108 percent while combination paperboard increased a scant 569,000 tons or 8.4 percent.

Over the same period of time, production of containerboard-type of paperboard made principally from virgin fibers increased 113 percent while combination containerboard only increased about 6 percent. Similarly, solid-type boxboard production increased 86.8 percent while combination boxboard production increased only about 10 percent.

A number of factors have contributed to the strong growth and demand for and production of solid paperboard at the expense of combination paperboard made

TABLE 25. TRENDS IN PRODUCTION OF COMBINATION AND SOLID WOODPULP PAPERBOARD BY TYPE

Type	Production, thousands of tons			Percent Increase, 1960-1969
	1960	1969	1960-1969 Increase	
Containerboard type	9,568	17,829	8,261	86.4
Combination	2,426	2,567	141	5.8
Solid	7,141	15,262	8,121	113.8
Boxboard Type	6,358	8,548	2,190	34.5
Combination	4,328	4,756	428	9.9
Solid	2,031	3,793	1,762	86.8
Total paperboard	15,927	26,378	10,451	65.6
Combination	6,754	7,323	569	8.4
Solid	9,172	19,055	9,883	107.9

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Source: Paperboard Industry Statistics, 1969, American Paper Institute, Paperboard Group, p. 9.

from secondary fibers.* Among these have been the increased availability of virgin wood pulp, resulting from production capacity increases by integrated companies, and a general desire on the part of packagers to upgrade their folding carton packaging by the use of solid bleached sulphate boxboard promoted as "white all the way through". The net result has been the creation of prejudices or biases against board made from secondary fibers which have been difficult to overcome. This relatively declining demand for combination paperboard has seriously arrested the growth of producers of combination paperboard exclusively and the combination paperboard operations of firms producing paperboard both from virgin wood pulp and paperstock. Efforts have been made to increase the efficiency of producing combination paperboard and to improve the quality of combination paperboard so that it will be indistinguishable from the virgin fiber product. The development and installation of the Inverform paperboard machine by Federal Paper Board Company, Inc., has been just one of such activities.

The relative decline in demand for combination paperboard has also had its impact upon dealer/processors of paperstock and the generators of wastepaper since it has been difficult for both of these links in the distribution chain to command sufficient revenue for the paperstock or wastepaper marketed. This, in turn, has resulted in increasing flows of wastepaper into solid waste channels.

Erratic Demand for Paperstock

The combination paperboard industry, which represents, of course, the prime market for paperstock, is characterized by a high degree of irregularity in

* Not all of the relative decline in demand for combination paperboard is attributable to growth of solidboard. Some traditional end uses for combination board, such as in cookie and cracker packaging, have suffered from the substitution of all-plastic packaging.

demand. The demand for end products, combination board folding cartons, fluctuates sharply through the year, and, in addition, most combination paperboard mills shut down for repair and service for several weeks during the month of July. Since mills do not, typically, inventory more than two or three weeks supply of paperstock, purchases are periodically cut back sharply in anticipation of reduced need. Mills contend that they cannot economically maintain the inventories which would stabilize these peaks and drops in demand because of the low value of paperstock relative to its weight and bulk. The prices at which end users of paperstock will buy the various grades of paperstock fluctuate throughout the year. When demand is high, higher prices are offered, and when demand is low, prices are reduced. This results in a continuing shift in the activities of wastepaper collectors. When demand is good and prices are favorable, collectors aggressively seek out new generator sources, but when demand is down, collectors do not find it economical to service marginal generators and use their trucks and labor for other purposes. This temporary or prolonged abandonment of some generators forces them to find new ways of disposing of waste. Further, the curtailment or change in activities of collectors resulting from erratic demand very often makes it difficult for dealer/processors to obtain the necessary supplies of wastepaper for conversion into paperstock when demand picks up.*

Lack of New Nonpaper Products

There is a critical need for new nonpaper products in which, preferably, the bulk grades of paperstock might be used as raw material, to counteract the relative decline in demand for paperstock in traditional paperboard applications. Producers of combination paperboard who operate cylinder machines have long sought to identify and exploit markets for such new products but, as yet, with

* For a further discussion of demand, supply, and prices of paperstock, see pages 4-62 through 4-76, Economic Study of Salvage Markets for Commodities Entering the Solid Waste Stream, prepared for the Bureau of Solid Waste Management by Midwest Research Institute, 1970.

little real success. The Boxboard Research and Development Council has been at the forefront of these activities.

Thus far, however, those newer uses for paperstock considered have, for the most part, either been uneconomical to market or have not promised sufficiently interesting potential sales volume. For example, one effort to produce and market a pelletized form of animal feed from paperstock was reportedly abandoned when it was determined that the costs of producing the feed in this form far exceeded the current market price for hay. The use of wastepaper in the form of cellulose insulation is interesting but, as yet, consumption of wastepaper for this application has been relatively small. The only new use for paperstock with a realistically large potential developed over the past decade has been as raw material for the newsprint deinking mills of Garden State Paper Company. Paperstock industry leaders, in general, have regretfully reported in recent months that there are no other new and exciting products on the horizon that might utilize wastepaper. Clearly, the critical need for new high-volume products and the satisfaction of this need affects the attitudes and actions of all levels in the movement of wastepaper. With assured markets for paperstock, some generators would be spared the costs of having to have wastepaper hauled away or incinerated. At the other end of the chain, mills would be encouraged once again to operate idle equipment or invest in such new equipment as would be required for the production of the identified new products. Lacking new products, in the face of past trends, the outlook for generators, collectors, dealers, processors, and users of paperstock would be dismal indeed were it not for the dynamic changes

which have occurred in the past year which have resulted in revived interest in traditional products made from paperstock.

Increasing Contamination

The development of new materials over the past two or three decades, used in conjunction with paper and paperboard products, has critically complicated the problem of sorting out economically recyclable wastepaper from the growing volume of wastepaper generated.

Table 26 lists the major contaminants found in wastepaper. The relatively new hot-melt adhesives and wet-strength papers, along with many different types of plastics and coatings, have been particularly troublesome to generators, processors, and users. Most users of paperstock who can also, if they so choose, economically use virgin wood pulp in the furnish for their products, refer to an element of risk in using secondary fibers. Although they may be able to produce their end product for \$30 to \$40 per ton less by using paperstock, they may be risking much more than the savings. If an undetected contaminant in the paperstock gets through to the end product, many tons of the finished end product have to be repulped or marketed at a reduced selling price. For this reason and in order to relieve the fears of users in this regard, the paperstock industry and the Paperstock Conservation Committee of the American Paper Institute have been making great efforts to increase awareness and improve recognition of potentially costly contaminants by persons generating and sorting wastepaper.

Absenteeism and Unavailability of Labor

All levels of distribution of wastepaper and paperstock are plagued by labor problems. The tasks of sorting and handling wastepaper at the generator

TABLE 26. MAJOR CONTAMINANTS IN WASTE PAPER

<u>SHINY PAPERS</u> Glassine Wax Ink Wads Fluorescent Lacquered	<u>PLASTICS</u> Films Synthetic Papers Plastic Foam Coated Boxes Shrink-wraps Cellophane	<u>ASPHALT & CARBON PAPERS</u> Insulation Bags Carbonless paper Bags with Black Liners Tar Laminated Boxes
<u>GLUES & TAPES</u> Hot Melt Adhesives Pressure Sensitive Tar Tapes Gummed Labels		<u>COATED & TREATED PAPERS</u> Photographic Blueprint Parchment Foil Wet Strength Filter
<u>BINDINGS</u> Thread Metal Plastic Rope Lates		<u>JUNK</u> Wire Wood Glass Metals Twine Paper Clips Rubber Bands Staples

Source: "Toby Trashound says, 'Keep These Out of Paper Stock!'"
American Paper Institute, Inc., 1970, Distributed by Paperstock
Conservation Committee.

level are repugnant to most of the workers who can be recruited to perform them. Because of lack of knowledge and interest in many generator organizations, it is difficult to set understandable standards or procedures for workers of low intellect to follow. Consequently, the necessary sorting tasks are often performed ineffectively. At the processor level, it is necessary to make the most economical usage of facilities and move the wastepaper through the plant as rapidly as possible. In the face of relatively declining demand and the generally unfavorable economics of paperstock distribution, packers cannot justify high rates of pay for the performance of sorting tasks. As a result, workers cannot be relied upon to report regularly for work at paperstock packing plants. Under conditions such as these, the economics of the plants suffer and commitments both to pick up accumulated wastepaper or deliver processed paperstock cannot be reliably met. Finally, because of the past image of the paperstock industry and the relative declines in paperstock usage, the industry has had difficulty in attracting young and educated talent with management potential talent to its ranks. The fairly recent surge of interest in ecology and recycling may, to some extent, alleviate some of this problem in the future.

Relatively High Costs of Transportation

Because wastepaper and paperstock are relatively low-value commodities in relation to their bulk, the costs of transporting them even short distances loom quite high. This unfavorable relationship tends to limit the scope of the marketing area, particularly for the lower priced grades, to a radius of about 100 miles from the point of collection or processing. As a consequence, dealers and users resourcefully develop means of minimizing transportation costs by using trucks employed to transport finished mill products to converting plants to

transport wastepaper to paperstock packing plants on return runs. The relatively high costs of shipping even the highest grades of paperstock overseas have also seriously hampered the growth of exports of paperstock to foreign countries which have a critical need for this commodity.

High Costs of Sorting

Related to the problems of increasing contaminants and unavailability of labor is the problem, principally at the dealer/processor level, of the high cost of sorting wastepaper into marketable grades of paperstock. Since so much reliance must be placed upon hand operations, the costs of sorting are often out of balance with the value of the incoming material to be processed. Although methods described in another section of this report are employed to make sorting and baling as efficient as possible, these methods have really been little changed over the past three or four decades and there has been little progress in automation of the necessary tasks. Consequently, there may be "a direct labor cost of \$20 or \$25 a ton" if wastepaper comes into a packing plant "mixed up" so that it is necessary to undertake "some of the slow sorting-type operations".* Clearly, these high costs affect all links in the chain of distribution of paperstock. If the responsibility for careful sorting were either pushed back to the generator level or pushed forward to the user level, the costs of handling the tasks would still remain and probably would be greater in the light of present-day technology.

* Presentation by Jean B. Charak at the Eleventh Tappi Deinking Conference, Chicago, Illinois, October 6, 1966.

Overpackaging

The most critical problem constraining recycling of paper has been expressed as the relatively declining demand for paperstock in the face of increasing demand for virgin fiber packaging. Some of this declining demand, in the view of many knowledgeable sources in the industry (even firms which have equal access both to virgin and secondary fibers), is purely the result of overpackaging stemming from psychological factors. Clearly, some industrial and consumer products such as hardware, sporting goods, toys, and others do not really need to be packaged in solid bleached sulphate cartons at greater costs than if packaged in combination board cartons. The high-quality standards set by merchandisers in many large packager organizations make it virtually impossible for producers of combination board to successfully solicit the business. The desires for solid white paperboard and freedom from small spots on the inner liner of a carton are formidable obstacles to combination board producers and have impact in the wastepaper industry all the way back to the generator level. Successful appeals to consumers and packagers can result in the lowering of artificially high standards. In past time frames, the appeal to patriotism during war years has been successful. Similarly, well-planned appeals to current interests in ecology may be equally as effective. Advocates of more direct action have advanced proposals to tax packaging on a basis reflecting degrees of sophistication of packages relative to products packaged.

Position of the Integrated Virgin Pulp Producers

As has been noted, the producers of paper and paperboard integrated with virgin pulp sources have enjoyed some competitive advantages over the users of

secondary fibers for at least the past decade. This has been the result of increased virgin pulp capacity and improved technology for producing virgin pulp. Further, integrated paper companies have practiced highly effective management of their forest resources to provide them with a continuing availability of pulpwood. Since 1960, paper companies have planted over 3 billion trees on their own land and have prepared ground extensively for natural reseeding. Research has also been conducted by forest products companies to increase the growth rate and enhance the disease resistance of the trees from which they draw their timber and to obtain the maximum yield of wood fiber.*

Captively produced wood pulp represented about 90 percent of all virgin pulp consumed in domestic paper and board mills in 1968. A large proportion of this captively-produced pulp was used by paper and board mills located adjacent to the producing pulp mills.** Also, the paper industry owns 50 million acres of commercial forests, which represent about 10 percent of total commercial forest lands in the United States, and leases several million acres of private forest lands in addition. (However, about two-thirds of the paper industry's wood requirements are currently obtained from the lands of farmers, other private owners and state and federal government agencies.)***

Concentration of Wastepaper Sources

The fact that wastepaper, for the most part, is generated in the populated areas in the northeast and northcentral states while the potentially largest users are located in the southeast and northwest, puts paperstock at a distinct economic disadvantage. With adequate forest resources located adjacent to producers' mills

* "The Paper Industry's Part in Protecting the Environment," American Paper Institute, 1970, p. 4.

** Economic Study of Salvage Markets for Commodities Entering the Solid Waste Stream, research study prepared by Midwest Research Institute for the Bureau of Solid Waste Management, 1970, p. 4-20.

*** "The Paper Industry's Part in Protecting the Environment", American Paper Institute, 1970, p. 17.

in the southeast and northwest, usage of paperstock in these areas has been and probably will continue to be moderate.

User Preferences for Virgin Fibers

There are many applications in which secondary fibers are superior to virgin fibers. In bending boxboard, for example, the secondary fibers provide superior bending qualities and printability. Yet there is a "stigma" attached to using products made from secondary fibers that has been and may continue to be difficult to overcome.

In addition, for many applications it appears to be technically true that virgin fibers are stronger than secondary fibers and provide superior end products. Producers of virgin fiber linerboard, for example, have been able to establish that corrugated shipping containers made mostly from virgin fiber linerboard and medium are stronger yet lighter in weight than ones fabricated from combination containerboard. The savings in shipping costs to users obviously may make the stronger and lighter container more attractive than the alternative container. However, this whole problem is now the subject of serious discussion and investigation.

Over Supplies of Bulk Grades

Restrictions on the use of incinerators in major metropolitan areas have, among other factors, resulted in over supplies of bulk grades of wastepaper. Since dumping sites are also becoming limited, greater quantities of old news, corrugated boxes, and mixed papers tend to flow to dealers. Without new markets and adequate demand for these grades, their value tends to fall so low that it is not economical to haul and handle them.*

Competition for Activities of Charitable Collectors

While the effects have not yet been generally recognized, increased activities by Boy Scouts and other charitable agencies in picking up used aluminum cans for recycling, could affect the economics of recycling old news. One of the main reasons why it has been economical, thus far, to recycle old news has been

* "Why Recycle Waste Paper When Surplus of Waste Paper is Being Destroyed or Burned," editorial from Waste Trade Journal, November 28, 1970.

the fact that the charitable agencies perform the collection operations at relatively low cost. If these agencies, because of the greater financial return promised, devote more of their activities to collecting aluminum cans or other items, collection of old news will decline.

Regional Differences in Problems

It has been noted that the wastepaper or paperstock industry is a fairly local business because of the low value of the commodity relative to its bulk. This fragmentation of the industry makes it difficult to make broad policy plans affecting the country as a whole. Adding to the complications is the fact that problems at the generator and collector level differ sharply from area to area. In large metropolitan areas, for example, the pressures to move out accumulated waste quickly are much more severe than they are in outlying areas. Accordingly, in the more populated areas, there is considerably less time and space available to undertake preliminary or secondary wastepaper sorting functions than in the outlying areas.

Legislative Restrictions

Two particular constraints on recycling of paper stand out. One of these, the set of obligations imposed on producers of folding cartons of combination paperboard, is no longer a current problem, but the unmeasurable impact of the problem ten years ago still remains. More than a decade ago when the Food Additives Amendment to the Food and Drug Act was passed, producers of folding cartons from combination paperboard were obliged to prove that their products could be safely used for packaging food products. While the producers were able to establish the safety of their products satisfactorily, the publicity

about their obligations was damaging to the combination board producers and indirectly helped the marketing efforts of the competing producers of solid bleached sulphate board.

The other type of legislative restraint that has highly deterring effects upon the paperstock industry is the maze of inconsistent zoning and licensing regulations in various parts of the country that make it difficult for sorting and packing plants to find facilities in which to operate. The contention is that these operations are unsightly and tend to reduce property values. The zoning regulations also impact on generators and users who, if not so constrained, might be able to undertake some of the sorting and baling operations that now must be performed by dealer/processors.

Irreversibility of Disposal Decisions

The erratic nature of demand for paperstock and the effects of fluctuations in demand have been noted earlier. Beyond these, however, are the constraints on recycling that result from difficulties in getting generators to reverse a decision, once made, to adopt means of disposing of wastepaper other than through collectors and dealers. It has been said that once the "business" type generator has made the decision to discontinue the generation (pre-processing and sale) of wastepaper based on a detailed cost analysis, it will take something more than the "price brings it out, price shuts it off" approach used with "street" generators to bring that industrially generated paper back into the usable secondary fibers market.* Executives are not likely to reverse such deliberate

* From an address on the use of secondary fibers by Dr. Wilbur H. Miller for the Empire State Annual TAPPI Meeting, Lake Placid, New York, June 12, 1965.

decisions because of a price fluctuation of uncertain size and uncertain duration. The only appeal likely to be sufficient to reverse such decisions would be some specific arrangement for a specific period of time.

There are also technical/economical reasons why it is difficult to alter policies regarding disposition of solid waste. "There is a segment of the public which feels that incineration is the solution to the solid waste crisis. It has been proposed as a quick solution. By burning it up, the problem disappears, according to its proponents. There is no question that incineration will do much of what is claimed.

"However, once the system is set up to incinerate, it would be very difficult to disturb this system and to ever be able to reclaim usable fiber. The design of incinerators is based on the amount of organic material available in waste, and any major change in the components upsets the operation of the equipment."*

Related to this constraint is the fact that generators who, because of low revenue for wastepaper generated, have invested in costly incineration equipment with the necessary scrubbers, etc. are reluctant to idle this equipment when the demand for and value of wastepaper returns to higher levels.

Factors Influencing Actions of Generators

In the foregoing section, problems constraining recycling at all levels in the distribution of wastepaper and paperstock were discussed. The following

* From an article "Debates on Recycling Paper Not New to Industry But . . ." by John H. Rich, President, Garden State Paper Company, Inc., Waste Age Magazine, July-August, 1970.

are problems unique to generators that have tended to minimize recycling and maximize disposition of wastepaper either through incineration or dumping.

Shortage of and High Cost of Space

The claimed unsightliness of the operations of sorting, baling, and storing of wastepaper has already been touched upon in the discussion of legislative constraints on recycling. Because of the desire to be "a good neighbor", a generator may avoid the sorting and baling functions that he might otherwise perform. Further, in congested metropolitan areas where production space is limited and costs for such space are relatively high, generators will be more inclined to employ limited and costly space for production of end products rather than for the handling of wastes.

Hazards in Handling and Storage

Wastepaper, when stored outdoors, is highly perishable. When stored indoors, large quantities of stored wastepaper present a potential fire hazard because it requires relatively little heat to set wastepaper afire. Also, tightly packed bales of wastepaper continually are in danger of breaking the bands that bind them in such a way as to cause severe physical injury to employees who may be working nearby. Finally, because of the relative unevenness of bales, there is constant danger that stacked bales will topple over, crushing nearby workers or equipment. In general, accumulations of wastepaper tend to slow down production operations and adversely effect the efficiency of a generator's plant.

Cost of and Space Required for Baling Equipment

While in some cases, as has been discussed in earlier sections of this report, dealer/processors supply baling equipment to generators of fairly homogenous wastepaper, in most cases the generator has to stand the cost of such equipment himself. Coupling the cost of the equipment with the cost of the space required for the installation of the equipment and the conduct of the necessary operations creates a cost burden which most generators are reluctant to accept. At the same time, generators are well aware of the fact that wastepaper, if not sorted at least in a preliminary way and baled, has relatively low value in the market place.

Unfamiliarity With Market Needs

Most smaller generators of mixed wastepaper are completely unfamiliar with the end uses to which the components of the mixed grades may be put if carefully segregated. Since this unfamiliarity exists at the managerial level, the problem is even more critical at the level of those assigned to do rough sorting of wastepaper and removal of contaminants.

Lack of Interest in the Waste Business

Except for big generators of relatively homogenous wastepaper, most generators are not particularly interested in the handling and disposition of waste materials. The feeling, generally, is that managerial skills and time can be more profitably devoted to the production and marketing of the company's own products. Accordingly, the responsibility for waste handling is pushed off on whatever personnel can be most easily spared for the obligations. Among large

generators of fairly homogenous wastepaper, it is quite common for the purchasing agent to bear the responsibility for disposal of wastepaper because of his skills in dealing with outside agents who compete with each other.

Factors Influencing Actions of Collectors,
Dealers, and Processors

Limited Cooperation From Generators

Many dealers contend that generators do not cooperate sufficiently with them, particularly in the area of warning dealers when new inks or new adhesives of a highly contaminative nature are used in the production of the generator's end product. If dealers know about the existence or intrusion of these contaminants in advance, steps can be taken to effectively assure that they are removed before they reach the unknowing users. Without cooperation and complete frankness in this regard, the problem of contaminants is seriously aggravated.

Tie Up of Vehicles

Because of the urgency of some generators' need to get wastepaper removed, they call on collectors to provide vehicles (trucks and trailers) often well in advance of real need. Consequently, these vehicles are tied up for extended periods of time and at high cost to the collectors or dealers who provide them.

Costs of Baling Equipment

In order to get generators to bale accumulated waste so as to minimize hauling costs, dealers are frequently obliged to underwrite the costs of the equipment provided. This obligation reduces the dealer/processor's net revenue in a framework in which prices for paperstock are greatly constrained by user-related factors.

Tie Up of Vehicles at Mills

Because paper and paperboard mills typically do not carry substantial inventories of paperstock, these mills frequently call upon dealer/processors to bring in shipments just before the time of most critical need. This may result in delays in unloading of trailers and extended "waiting time" at the mills. Since the value of these vehicles is high and the time of the personnel assigned to operate them is costly, dealers are forced to absorb unanticipated costs which they are not in the position to pass along.

Extraordinary Demands by Users

In situations when competition for the business of major mills is keen, mills frequently force processors to undertake a degree of sorting not justified by the prices paid. For example, a mill may offer to pay only the going price for a relatively roughly sorted grade of old corrugated and expect to receive a grade which does not require any further mill level sorting.

Poor Image of the Industry

Paperstock dealers and processors like other dealers in secondary materials have been plagued for generations by an image that has made it difficult

for the industry to command respect in business society. In an effort to offset the effects of this image weakness, the industry has, in recent years, tended to shun the use of the terms "wastepaper", "scrap", "junk", "trash", etc. and to adopt more euphonious terminology. There are clear signs that the current interest in ecology is putting the industry in a more favorable light and will make it easier for the industry to offset the effects of the intangible limitations under which it suffered in the past.

Relatively Small Size of Organizations

The paperstock industry is made up of a relatively great number of small companies fairly well confined to local markets. As such, the industry has been unable to support research and development activity at a level comparable with that undertaken by large integrated producers of virgin pulp. While virgin pulp producers have continually taken steps to improve technologies related to sources (forest management) and the production of virgin pulp, paperstock dealers and processors have been fairly well confined to techniques established 30 or 40 years ago. The paperstock industry has made great strides, relative to its size and capabilities, with the adoption of the use of new forms of materials-handling equipment, hogging and shredding equipment, and baling equipment but, for the most part, operations are quite unsophisticated. Again, until recently, there was little incentive for processors to make the investment called for. However, in light of rapidly changing conditions, attitudes in this regard are changing as well.

Difficulties in Exporting

While it is well established that substantial demand for U.S. paperstock exists in foreign countries suffering from fiber shortages, only a relatively few of the larger paperstock dealers appear to be in a position to participate in export marketing. Again, the relatively small size of so many companies in the industry makes the problems of exporting loom rather formidable. Even some larger dealers interviewed in the course of the intensive survey seemed to be reluctant to pursue export markets. The contention was that export shipments are troublesome and costly to make. The heavy volume of paperwork necessary in preparing export shipments, the delays in port facilities on the East Coast, and other "headaches" appear to make export marketing unattractive to any but the largest processors who can support the necessary trained specialists. Obviously, too, the high cost of shipping paperstock, relative to its value, makes it necessary for the dealer/processor to be extremely resourceful in finding profitable outlets for his products in foreign countries.

Changing Philosophies in Customer Organizations

Veteran management level personnel in paperstock processing companies bemoan the changes in thinking and organization in their traditional outlets for paperstock. Rigid policies as to delegation of responsibility in using mills, from the presidential level down to the purchasing agent, make it difficult for both users and processors to benefit from special "deals" which become available from time to time. Paperstock is not a homogenous manufactured product. As such, quantities become available, frequently, from sources not normally anticipated. These may be in the form of side runs or damaged rolls of paper that are

not normally available. In past years, owners of paperstock processing firms simply phoned owners of mills or announced the availability of these unanticipated supplies and negotiated the sale of them directly. Today, however, with the responsibility for all purchasing delegated to a buying department accustomed to buying and bound by policy to buying standard products, these "deals" cannot be so easily negotiated. The effort to impose rigid policies on an industry that depends for its existence on products which are "produced manually and may not be technically perfect"* has had significant constraining effects.

Factors Influencing Actions of Paperstock Users

In addition to such general factors as the relative decline in demand for products made from paperstock, the problems of contamination, increasing costs, and others which tend to constrain recycling at all levels in the distribution of wastepaper and paperstock, there are a few specific factors which are unique to users.

Inadequate Comparative Figures

While it has been demonstrated that there are some applications for which paperstock is not suitable and others for which use of wood pulp is infeasible, there still remain a number of situations in which one commodity is clearly substitutable for the other. This is the case, particularly, where the alternatives to a paper mill may be a particular high deinking grade of paperstock or a virgin pulp. The users who have already invested in deinking facilities and

* From Section VI, "Grade Definitions", of "Paperstock Standards and Practices-PS-70," published by Paperstock Institute of America, a commodity division of National Association of Secondary Materials, Inc.

employ both virgin pulp and deinking grades of paperstock in their furnishes generally have a fair understanding of the comparative economics of using one raw material versus the other.

Unfortunately, however, there are other mills using both secondary and primary fibers who cannot so clearly establish the comparative costs of using one raw material versus the other. Further, mills who do not presently use secondary fibers have little data to guide them in planning future actions.*

Tables 27, 28, 29, and 30 show comparisons of prices of paperstock and market pulp and trends over the past decade. However, because of the multiplicity of cost factors involved, the variations in grades of paperstock and virgin wood pulp, the differences in market conditions in the various geographical regions, and the unique circumstances in individual companies, it is difficult to make generalizations as to the comparative economic advantages of using virgin fibers versus secondary fibers. Without some meaningful and reliable data, the possibilities of getting a mill to switch from virgin to secondary fibers is critically minimized.

The question to be resolved is "Who can and should take the responsibility for making the necessary determinations?". In the area of primary materials, generally the obligation rests with the producers or manufacturers who convince the users of the benefits of using their products in preference to alternatives. For example, plastics manufacturers develop bodies of data to show users the advantages of using plastics in preference to paper or metals. However, paperstock is not a manufactured product in the normal sense and the suppliers, the paperstock dealers, for the most part, have not had the resources to commit to market development in this sense.

* "Paperstock in the Paper Industry--A Technical Analysis," Wilbur H. Miller, TAPPI, April, 1964.

TABLE 27. APPROXIMATE DEALERS BUYING PRICES FROM GENERATORS OF
PAPERSTOCK IN NEW YORK IN LATE NOVEMBER, 1970^(a)

Category and Grade	Range of Prices per Ton
Low or Bulk Grades	
No. 1 mixed paper	Nominal - \$2.00
Folded news, ordinary	\$7.00 - 8.00
Old corrugated boxes	7.00 - 9.00
High Grades	
High Grade Deinking Grades	
Ledger stock, colored	17.50 - 20.00
No. 1 books and magazines	Nominal
High Grade Pulp Substitutes	
Double lined new corrugated kraft cuts	22.50 - 27.50
Ledger stock, white	25.00 - 27.50
No. 1 soft white shavings	35.00 - 40.00
No. 1 hard white shavings	35.00 - 40.00
No. 1 hard white envelope cuttings	55.00 - 57.50

(a) Fibre Market News, November 27, 1970, p. 4.

TABLE 28. PRICES QUOTED FOR SELECTED GRADES OF PAPERSTOCK BY MAJOR DEALERS AND BROKERS IN LATE NOVEMBER, 1970^(a)

(c)	Category and Grade	Range of Prices per Ton (b)		
		New York	Boston	Los Angeles
<u>Low or Bulk Grades</u>				
(2)	No. 1 mixed paper	\$ 1.00 - 5.00	\$ 3.00 - 7.00	\$ 4.00 - 7.00
(6)	No. 1 news	5.00 - 7.00	5.00 - 7.00	8.00 -12.00
(10)	Old Corrugated containers	12.00 -20.00	16.00 -18.00	17.00 -20.00
<u>High Grades</u>				
<u>High Grade Deinking Grades</u>				
(38)	No. 1 colored ledger	20.00 - 27.50	35.00 - 40.00	25.00 - 30.00
(43)	No. 1 books	4.00 - 11.00	16.00 - 18.00	4.00 - 9.00
<u>High Grade Pulp Substitutes</u>				
(13)	Doubled lined kraft corrugated cuts	27.50 - 45.00	22.50 - 27.50	22.50 - 27.50
(40)	White ledger	25.00 - 32.50	42.00 - 47.00	37.50 - 47.50
(28)	No. 1 soft white shavings	37.50 - 42.50	50.00 - 55.00	40.00 - 50.00
(30)	Hard white shavings	57.50 - 80.00	80.00 - 85.00	75.00 - 80.00
(31)	Hard white envelope cuttings	60.00 - 85.00	100.00 -105.00	82.50 - 87.50
				82.50 - 90.00

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(a) Paper Trade Journal, December 7, 1970, p. 48.

(b) Mill prices, f.o.b. truck shipping point, Volume tonnage including brokerage.

(c) Indicates grade number per PSIA paper stock standards and practices, Circular PS-70.

TABLE 29. DELIVERED PRICES OF LEADING GRADES OF MARKET WOOD PULP IN DECEMBER, 1970^(a)

Grade of Wood Pulp	Source			
	U.S.	U. S. Delivered Price per Ton		Finnish
		Canadian	Swedish	
Groundwood	\$ 90/ 95	\$ 90/ 95	N.A.	----
Bl. groundwood	100/105	100/105	N.A.	----
Kraft Bl. Stwd.	169/172	169/172	174/179	\$172/-----
Kraft Bl. Hwd.	146/155	146/148	N.A.	162/-----
Kraft Semi-Bl.	163/164	163/164	N.A.	167/-----
Kraft Unbl.	130/145	---/152	N.A.	152/157
Sulphite Bl.	162/167	162/167	162/180	169/172
Sulphite Unbl.	142/147	142/147	N.A.	154/157

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(a) Paper Trade Journal, December 7, 1970, p. 48.

TABLE 30. WHOLESALE PRICE INDEXES, WOOD PULP, WASTEPAPER, PAPER, BOARD, CONVERTED PRODUCTS, AND ALL INDUSTRIAL COMMODITIES, 1959-1969.

[1957-59 = 100, except as noted]

Item	1969 ¹	1968 ²	1967	1966	1965	1964	1963	1962	1961	1960	1959
All industrial commodities	112.7	109.0	106.3	104.7	102.5	101.2	100.7	100.8	100.8	101.3	101.3
Pulp, paper, and products group	108.2	105.2	104.0	102.6	99.9	99.0	99.2	100.0	98.8	101.8	101.0
Wood pulp subgroup	98.0	98.0	98.0	98.0	98.1	96.1	91.7	93.2	95.0	100.2	100.7
Sulfate, unbleached	102.1	102.1	102.1	102.1	103.1	102.9	98.1	98.8	100.0	100.0	100.0
Sulfate, semibleached ¹	109.2	109.4	109.4	109.4	109.4	105.9	97.7	98.1	n.a.	n.a.	n.a.
Sulfate, bleached	96.1	96.1	96.1	96.1	96.1	94.5	90.6	91.5	94.4	100.1	100.6
Sulfite, bleached	95.7	95.7	95.7	95.7	95.7	92.8	88.2	90.2	91.0	100.0	100.8
Sulfite, unbleached ¹	101.2	101.2	101.2	101.2	101.2	98.0	95.0	97.3	n.a.	n.a.	n.a.
Groundwood	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Soda, bleached	90.8	90.8	90.8	90.8	90.8	86.1	82.6	87.7	89.9	100.1	100.8
Waste paper subgroup	108.3	101.5	78.1	105.0	99.4	92.4	92.2	97.5	80.5	90.3	121.4
No. 1 news	150.6	167.9	122.5	123.0	121.3	110.2	119.0	122.8	90.2	89.2	111.6
No. 1 mixed	110.0	99.8	65.4	103.2	104.6	94.7	98.5	109.7	n.a.	n.a.	151.0
Old corrugated boxes	101.5	92.9	72.2	119.2	99.5	98.3	90.8	93.8	82.3	84.7	108.3
.009 semichemical kraft clippings ¹	114.2	96.2	76.6	116.3	108.8	101.8	90.8	98.2	n.a.	n.a.	n.a.
.009 mixed kraft clippings ¹	122.0	101.8	77.4	124.6	114.7	107.7	95.8	100.7	n.a.	n.a.	n.a.
White news blanks ¹	99.8	102.5	111.7	118.6	116.7	106.1	101.3	100.6	n.a.	n.a.	n.a.
Paper subgroup	116.6	112.7	110.0	107.3	104.1	103.6	102.4	102.6	102.2	102.0	100.6
Paper except newsprint	119.2	115.3	112.1	109.4	106.1	104.9	103.1	103.4	102.9	102.7	100.7
Printing paper	102.7	101.5	101.9	101.7	101.4	101.4	101.4	101.4	101.7	102.6	101.6
Book paper, A grade	122.9	119.4	117.6	115.1	110.6	109.4	107.4	107.6	106.1	105.5	101.9
Book paper, No. 2 Pl. offset	125.6	121.4	118.5	115.4	110.8	109.7	107.4	107.0	105.7	n.a.	n.a.
Wood bond	124.1	120.6	114.1	111.0	106.7	106.2	104.3	103.7	102.6	102.6	101.8
Writing paper	125.8	121.8	111.3	113.2	109.2	106.3	104.2	103.0	101.8	101.7	100.6
Wrapping paper	117.7	110.2	107.7	104.0	101.3	97.0	93.5	98.6	100.	101.3	98.6
Butcher's paper	117.5	112.6	109.3	107.6	105.4	102.7	100.4	101.2	101.4	102.0	100.2
Waxing paper	102.3	102.1	101.5	101.0	100.1	99.9	99.9	99.9	99.8	99.8	99.8
Wrapping tissue	111.8	111.3	108.8	107.3	104.2	104.1	102.7	102.7	100.4	97.6	97.9
Newsprint	108.9	105.4	104.3	101.6	98.7	100.1	100.2	100.2	100.2	100.2	100.2
Paperboard subgroup	94.4	92.2	97.3	97.1	96.4	96.4	94.7	93.1	92.7	99.4	99.9
Container board ⁴	91.1	89.0	97.5	97.5	97.5	97.5	94.6	92.4	91.2	99.6	100.0
Linerboard ⁴	94.3	92.3	100.0	100.0	100.0	100.0	n.a.	94.7	95.0	n.a.	n.a.
Corrugating medium ⁴	84.3	82.1	92.3	92.3	92.3	92.3	n.a.	87.6	82.9	n.a.	n.a.
Folding boxboard	98.1	96.1	95.9	95.3	93.5	93.6	94.0	93.6	93.9	99.3	100.0
Setup boxboard	106.5	101.9	99.6	99.2	97.2	97.4	97.7	97.1	96.9	99.1	99.6
Converted products subgroup	108.8	105.9	104.8	102.3	99.3	98.3	99.7	101.0	99.5	102.8	100.3
Sanitary papers, etc.	119.6	114.2	109.7	104.3	101.2	100.5	100.8	101.1	101.9	102.9	100.3
Paper bags, shipping sacks	102.4	98.4	103.9	102.7	96.8	90.4	90.1	97.9	99.1	99.6	99.6
Boxes, shipping containers	108.0	105.1	103.3	101.1	98.7	99.1	101.8	101.8	98.4	103.9	100.6
Gummed tape	104.8	103.4	102.6	102.4	99.6	98.5	98.7	99.8	101.3	103.6	98.7
Games, toys, novelties	117.4	115.0	112.8	102.0	102.0	102.0	102.0	102.0	98.7	100.4	100.4
Office supplies	107.2	107.4	107.2	106.3	103.6	102.9	103.1	102.3	102.3	101.5	100.2
Composite cans ³	107.7	105.8	102.8	100.7	102.4	101.3	n.a.	n.a.	n.a.	n.a.	n.a.
Building board subgroup	97.1	92.8	91.9	92.6	92.7	94.0	96.3	97.2	100.8	101.4	101.8
Insulation board	97.8	92.7	89.7	88.3	88.1	90.1	92.1	94.5	101.0	102.2	102.5
Hardboard and particleboard ³	98.7	95.0	95.9	99.2	99.8	99.9	101.8	101.0	100.0	99.5	100.3

¹ Index based on January 1962 prices.
included only beginning in 1968.

² Index based on December 1963 prices.

³ Index based on January 1958 prices. Particleboard included only beginning in 1968.

⁴ The lower levels for the container board indexes beginning in 1968 were caused by a change in the reporting method to reflect discounts from published list prices.

Source: U.S. Department of Labor, Bureau of Labor Statistics, Wholesale Prices and Price Indexes.

SOURCE: Pulp, Paper and Board, April, 1970, p. 32.

Technical Imperfections in Supplies

Users of paperstock, for the most part, hold that the key to successful use of paperstock is the selection of reliable dealer/processors. This is said to be the best insurance against getting inferior supplies of raw materials containing undetected contaminants. Yet, paperstock can never be guaranteed as "technically perfect" and dealer/processors still must rely upon the cooperation, frankness, or honesty of the generators. When undetected contaminants do get by the processor's scrutiny, the user does not concern himself with problems at the generator level but takes the dealer/processor to task. Users contend that these instances of inferior raw materials stem from the inability or unwillingness of the dealer/processors to control their sources of supply, the generators. Unfortunately, as has been demonstrated in other sections of this report, the proliferation of contaminants, the general pressures on dealer/processors, and other factors make this "control" difficult for dealer/processors to exercise.

Environmental Pollution

Although it is true that the operation of a deinking plant and other cleaning facilities in conjunction with a paper mill produces residues of waste (ink, clays, and other materials) not produced when the raw material is virgin market pulp, the environmental pollution resulting from the use of paperstock has been shown, under some circumstances, to be far less than that resulting from the operation of wood pulping facilities and a slush pulp system adjacent to a paper or paperboard mill. In recent months, Container Corporation of America

announced the conversion of a corrugating medium mill in Carthage, Indiana, from a wood-base material mill to a paperstock material mill. It was reported that water and air pollution problems resulting from the wood pulping operations would thereby be eliminated.*

Nevertheless, a major pressure on users of paperstock is the need to dispose of residues generated in deinking and cleaning. A leading producer of printing papers in southwestern Ohio has, for this reason, made a substantial investment in equipment over the past few years permitting the mill to thicken its residual clays etc. so this waste material may be readily hauled away. The point was also made that if new uses could be developed for these residual clays, then the mill would not have to pay to get the material hauled away and the economics of using the paperstock as raw material would be substantially improved.

* Boxboard Containers Magazine, July, 1970, p 84.

DYNAMIC AND CHANGING ASPECTS
OF THE PAPERSTOCK INDUSTRY

Over the period of time during 1970 and 1971 when the research upon which this report is based was conducted, many changes occurred that have affected the paperstock industry. The major impetus for these changes has been the growing awareness of the magnitude and serious nature of the solid waste problem and the realization by society of the important role the paperstock industry has played in the past and can play in the future to minimize solid waste accumulation.

Up until quite recently, almost all discussions of paperstock and the paperstock industry tended to deal with the volume of paper being recycled. Little note was made of the great volume of paper and paperboard not recycled that has moved into solid waste channels. Table 31 summarizes the magnitude and character of the solid waste problem in terms of the various categories of paper and paperboard not recycled. In 1969, it is estimated that a total of 46.8 million tons of paper, consumed and potentially available for recycling, moved into solid waste channels.

The Impact of the Solid Waste Problem

With the growing awareness of the solid waste problem and the role which the paperstock industry could play in alleviating the problem, the paperstock industry has acquired a new identity and new image. Dealers and users have received inquiries from environmentally concerned members of society as to how the public can assist the paperstock industry in minimizing solid waste accumulation. The industry response has been that the most constructive action which consumers can take is to specify products made from secondary fibers. Recognizing

TABLE 31. IDENTIFICATION OF QUANTITATIVE PROBLEMS OF PAPER RECYCLING, 1969

Title	Total U. S. Consumption of Paper and Paperboard	Permanent or Semi-Permanent End Use Categories
PROBLEM DEFINITION	As annual consumption of paper and paperboard increases and the percentage of material recycled decreases, the quantity of waste-paper falling into solid waste channels increases significantly	These categories generally are not considered to be economically recoverable because of difficulties of collection and/or separation.
THOUSANDS OF TONS CONSUMED AND POTENTIALLY AVAILABLE FOR RECYCLING (a)	58,200	10,000 ^(b)
THOUSANDS OF TONS RECYCLED ^(a)	11,400	--
THOUSANDS OF TONS NOT RECYCLED ^(a)	46,800	10,000 ^(b)
% NOT RECYCLED ^(a)	81	100 ^(b)
PROBLEM BACKGROUND	1. Average annual per capital consumption is about 575 pounds per person. 2. Consumption is growing at an annual rate of about 4.5 percent. 3. 12,000 kinds of paper and paperboard are utilized in more than 100,000 end uses. 4. Major product groupings based on end use are communications papers, packaging papers and boards, construction and industrial papers and boards, and sanitary and personal use papers. 5. Percentage of recycled paper has declined from 26% in 1959 to 19% in 1969. 6. NASMI (PSIA) and EPA are focusing public attention on the need for (a) increased recycling as a means of reducing future solid waste problems and conserving natural resources and (b) increased purchasing of recycled fiber products.	1. Some grades are permanent or semi-permanent end use products in themselves. 2. Others are incorporated into products having long-term use. 3. Categories include: papers for permanent records and publications, construction paper and board, and papers in electronic automotive, and other manufactured end uses. 4. This is not a promising area in which to increase recycling of paper.

SOURCES: (a) The Statistics of Paper, 1970 Supplement. American Paper Institute, p. 24, 26.

(b) Pulp, Paper, and Board; BDSA Quarterly Industry Report; U. S. Dept. of Commerce; October, 1970; p. 8-10.

TABLE 31. IDENTIFICATION OF QUANTITATIVE PROBLEMS OF PAPER RECYCLING, 1969

Title	Newspapers	Containerboard
PROBLEM DEFINITION	Fluctuating and relatively declining demand for combination paperboard and high transportation costs (resulting from distances from adequate sources to markets) limit recycling of old news.	Fluctuating and relatively declining demand for combination paperboard and high transportation costs limit recycling of containerboard.
THOUSANDS OF TONS CONSUMED AND POTENTIALLY AVAILABLE FOR RECYCLING (a)	9,800	15,900
THOUSANDS OF TONS RECYCLED (a)	2,400	3,900
THOUSANDS OF TONS NOT RECYCLED (a)	7,400	12,000
% NOT RECYCLED (a)	76	76
PROBLEM BACKGROUND	1. These become available as wastepapers in households, institutions, newspaper plants, retail dealers and distributors. 2. Substantial amounts of old news are collected by charitable agencies. 3. Some communities are calling on residents to segregate old news collected. 4. Relatively greater amounts of old news were recycled during World War II because of shortages of virgin pulp and patriotic motivation of consumers to save and turn in old newspapers. 5. Old news is used principally in production of combination paperboard, for which demand has been declining relative to solid paperboards. 6. De-inking of old newspaper for use in production of de-inked news is a relatively new and growing end use.	1. This is the single paper and paperboard product produced in largest volume. 2. Consists of linerboard and medium and is converted into packaging and shipping containers. 3. Very little ends up as waste in the residential sector. 4. Major amounts recycled are recovered from converting plants and wholesale and retail establishments. 5. Along with old news, old corrugated containerboard is used principally in production of combination paperboard, but increasing quantities of old corrugated are moving into production of new containerboard.

TABLE 31. IDENTIFICATION OF QUANTITATIVE PROBLEMS OF
PAPER RECYCLING, 1969

Title	Pulp Substitutes and Mixed Papers
PROBLEM DEFINITION	Under present conditions, demand and supply are approximately in balance for pulp substitutes, which are fairly homogeneous clippings and other wastes from printers and converters. Mixed papers include thousands of different grades of paper and paperboard in various states of contamination by inks, coatings, laminations, etc., and therefore are difficult to recycle.
THOUSANDS OF TONS CONSUMED AND POTENTIALLY AVAILABLE FOR RECYCLING (a)	22,500
THOUSANDS OF TONS RECYCLED ^(a)	5,100
THOUSANDS OF TONS NOT RECYCLED ^(a)	17,400
% NOT RECYCLED ^(a)	77
PROBLEM BACKGROUND	1. Mixed papers originate as wastes in offices, plants, retailers, wholesalers, institutions, and households. 2. If demand for end products made from secondary fibers increases, segregation or sorting of mixed papers into marketable grades will be encouraged. 3. Toilet tissue consumed, which represents 1.3 million tons per year, is not recoverable.

that the combination paperboard industry has traditionally been the major user of paperstock, the paperstock industry has urged that consumers demand that the products they purchase be packaged in containers made from combination paperboard. As a major processor has said:

We know, as dealers that the secondary fiber using mills have much capacity which is not being used and can produce larger amounts of materials from recycled fiber, if the demand exists. The message we expect to leave with you (consumers) is that demand will develop markets, and all of us, as the consumers, must create this demand.*

Changes in Purchase Specifications
and Procurement Policies

In response to the urgings of various organizations interested in environmental quality, buyers of paper and paperboard products in government and industry have started to shed their bias toward materials made from virgin fibers. These biases, in many cases, have been manifested in the form of purchasing specifications that have limited the markets for products made from secondary fibers.

As a result of the collective efforts of EPA, CEQ, and the paperstock industry, specification changes have been initiated by some government agencies and other organizations. The City of New York recently advised that it would be purchasing various grades of office paper made from reclaimed fibers. One of the larger banking institutions in New York City began the utilization of paper made from recycled fiber, and the paperstock industry, early in February of 1971, anticipated that other corporations would follow this lead in the near future.*

* From an address by Haskell Stovroff of Buffalo Paperstock Company and chairman of NASMI's Solid Waste Utilization Committee at the Wastepaper Work Shop held during Recycling Day in New York City, February, 1971.

The Federal government has also taken a new look at its paper purchasing practices. Early in 1971, President Richard M. Nixon announced in his Environmental Message that the General Services Administration (GSA) had revised 14 specifications for paper products amounting to approximately one third of the total purchases of "supply paper" by GSA. The other 12 specifications were under review at the time.* (The latest GSA definition for reclaimed fiber available when the research was performed appears in Appendix A.)

Removal of Regulatory Restraints

A great many individual local regulatory restraints on the paperstock industry and other sectors of the secondary materials industry have been identified and earmarked for study and reevaluation. As M. J. Mighdoll has commented, "Does it amaze you that we demand solid waste collection and more recycling in our cities-- and then construct municipal regulations that remove the companies equipped to do this from the urban community?"**

Recent Progress and Outlook

Many of the actions considered and recommended in the next major section of this report are already being undertaken by the paperstock industry. In the months ahead, it is anticipated that more of the recommendations will be implemented and still other potentially constructive courses of action will become apparent.

In an address to the Technical Association of the Pulp and Paper Industry in New York City in late February of 1971, F. S. Crysler, Executive Vice President

* Brown, G., "The Federal Government and Recycling", American Paper Industry, April, 1971.

** From an address by M. J. Mighdoll, Executive Vice President, NASMI, at Recycling Day in New York, Waldorf Astoria Hotel, February 2, 1971.

of Container Corporation of America, concluded, "There is a solid waste pollution crisis. Part of the solution is incineration combined with heat recovery or power generation. The other part of the solution is the proper utilization of secondary paperstock. You can provide the impetus to speed the acceptance of those recycling concepts."

CONCLUSIONS AND RECOMMENDATIONS

Analytical Approach and Conclusions

An earlier section of this report focused on the problems constraining the recycling of paper. These problems were organized, arrayed, and discussed under four basic categories:

- (1) Those broad and general in impact
- (2) Those which have been influencing the actions of generators principally
- (3) Those which have been influencing the actions of collectors/dealers/processors
- (4) Those which have been influencing the actions of paperstock users.

A great many actions which might be undertaken in response to problems or factors constraining the recycling of paper were identified or suggested during the literature search, intensive survey, and analysis phases of the study. These remedial actions, which are reviewed in Appendix B, typically were one of the following types:

- (1) Technical research and development efforts to improve current products or procedures

- (2) Research and development activities leading to new products
- (3) Economic and marketing research and development activities.

Further analysis of both problems and possible remedial actions was necessary in order to focus effectively on major problems and establish priorities of action. As this analysis proceeded, it became apparent that many of the problems identified as constraining recycling were interrelated or, in some instance, symptomatic of other problems. Groups or related "families" of problems, therefore, were reorganized into the following six general problem areas:

- (1) Relatively declining demand for products made from paperstock
- (2) Erratic demand for paperstock
- (3) Need for new products made from paperstock
- (4) Increasing contaminants in wastepaper
- (5) High cost of transportation
- (6) Operational problems at all levels.

These general problems and the remedial actions considered in each area are summarized in Table 32.

Problems in some of the areas more urgently require solutions than problems in other areas, and some problems might be more readily and more completely solved than others. Table 33 ranks the six general problem areas in order of priority, considering criteria that reflect problem urgency and ease of solution.

Time and budget limitations of the study did not allow detailed analysis of each of the remedial actions considered (listed in Table 32 for each general problem area) in order to select recommended actions. The action recommendation selections represent the best judgments of the Battelle project team and members of the NASMI Commodity Committee, who drew upon their past experience

TABLE 32. IDENTIFICATION AND ANALYSIS OF QUALITATIVE PROBLEMS AFFECTING RECYCLING

Problem Area	Relatively Declining Demand for Products Made from Paperstock	Erratic Demand for Paperstock
Problem Definition	1. Demand for combination paperboard cartons has not increased at the rate of that for cartons of virgin fiber, therefore, virgin fiber paperboard producers have gained an increasing share of the market. 2. Some knowledgeable users and research groups consider virgin fibers to be superior to secondary fibers in certain high volume end uses, especially where high strength is required. 3. Packaging buyers sometimes choose to overpackage (use virgin fiber containers where secondary fiber containers would suffice) to enhance the marketability of their products.	1. Paperstock demand fluctuates as demand for paper, board, and/or converted products fluctuates. Some seasonality because of mill shutdowns in summer. 2. Mills are reluctant to carry extensive paperstock inventories. 3. Paperstock is perishable and hazardous to handle and store. 4. Space for storage of paperstock is both limited and costly. 5. Some collectors go out of business when demand is low.
Effect on Recycle Rate	Major constraining effect on recycling of paper.	Major impact on paperstock industry and, hence, on recycling of paper.
Remedial Actions Considered	1. Improve techniques for making paper, board, and converted products from paperstock to be more competitive with those made from virgin fibers. 2. Develop strategies to increase acceptance of these products. 3. Develop educational programs to offset the stigma associated with recycled materials. 4. Determine the economic impact and various other impacts of legislation to restrict use of virgin fibers. 5. Provide incentives to invest in new capacity to use secondary fibers or resume use of idle capacity. 6. Encourage the government and others to specify products made from recycled paper.	1. Improve methods of compacting and hogging paperstock so as to conserve storage space. 2. Investigate techniques for pelletizing wastepaper or paperstock. 3. Encourage negotiation of longer term contracts for paperstock. 4. Provide incentives for increased warehousing by processors and users. 5. Encourage the government to stockpile paperstock.

TABLE 32. IDENTIFICATION AND ANALYSIS OF QUALITATIVE
PROBLEMS AFFECTING RECYCLING (Continued)

Problem Area	Lack of New Products Made from Paperstock
Problem Definition	1. Many authorities in the paperstock industry feel that successful development of new products made from paperstock is the "major factor" that will materially increase recycling. 2. Oversupplies of bulk grades of paperstock add to the solid waste problem. 3. The only significant new use for paperstock developed in the past decade has been as raw material for newsprint de-inking mills of Garden State Paper Company.
Effect on Recycle Rate	Development of new uses for paperstock necessarily will increase recycling.
Remedial Actions Considered	1. Investigate the possibility of combining bulk wastepaper with waste textiles to result in new materials and to solve two environmental problems simultaneously. 2. Investigate the possibility of combining waste paper with lignins or tall oil to result in new materials. 3. Investigate alternative methods of separation of paper fibers in waste paper. 4. Ideas for possible new products should be first screened as to market feasibility (size and character of market, etc.) before extensive technical research is performed.

TABLE 32. IDENTIFICATION AND ANALYSIS OF QUALITATIVE PROBLEMS AFFECTING RECYCLING
(Continued)

Problem Area	Increasing Contaminants	High Costs of Transportation
Problem Definition	1. Development and introduction of new coatings, laminations, adhesives, etc., over the past two or three decades have increased contamination of waste paper generated. 2. High costs of sorting and the dependence on hand labor make the proliferation of contaminants a major factor constraining recycling. 3. Most generators are unfamiliar with the needs of markets for paperstock and the problems created by contaminants. 4. Most generators are not interested in the waste business and have not been motivated to cooperate with the paperstock industry. 5. Users of paperstock often impose extraordinary demands on suppliers or question reliability of supplies and suppliers.	1. Costs of transporting wastepaper represent a high percentage of total costs because wastepaper has low value relative to its bulk and weight. 2. Waste paper sources often are concentrated in geographic areas distant from users, resulting in high shipping costs. 3. Variations in local supply/demand situations make it difficult to establish broad national policies. 4. "Red tape" tends to restrict exporting of paperstock.
Effect on Recycle Rate	Major constraining effects on recycling of paper.	Major impact on paperstock industry and, hence, on recycling of paper.
Remedial Actions Considered	1. Develop inks, coatings, adhesives, etc., which do not inhibit recycling for use in printing and conversion. 2. Improve techniques for segregating wastepaper at the generator level. 3. Improve techniques for sorting at all levels. 4. Improve methods for cleaning and de-inking at the user level. 5. Consider legislation to penalize producers or users of contaminating materials.	1. Develop more economical means of transporting wastepaper and paperstock over both short and long distances. 2. Consider establishment of freight rates more favorable to shippers of wastepaper and paperstock. 3. Consider subsidies to dealers or processors to offset the high costs of overseas shipments now restricting exporting. 4. Consider feasibility of producing "market pulp" from paperstock.

TABLE 32. IDENTIFICATION AND ANALYSIS OF QUALITATIVE PROBLEMS AFFECTING RECYCLING
(Continued)

Problem Area	Operational Problems
Problem Definition	1. At wage rates usually offered for processing wastepaper, labor is either undependable or unavailable in many areas where paperstock is generated or processed. 2. By certain standards, some environmental pollution results from use of paperstock for making paper. 3. There is a need for more and better economic analyses to support arguments for using paperstock instead of virgin fibers. 4. The paperstock industry has suffered from a poor image. 5. Many paperstock organizations are relatively small. 6. Dealers' trucks often are tied up at locations of generators and users for excessive time periods. 7. Baling equipment is costly and occupies costly space. 8. Users often consider risks in using paperstock to be relatively high because of the limited liability of dealers. 9. Growing competition for the efforts of charitable agencies that collect wastepaper may add to collection costs. 10. Changing philosophies in customer organizations tend to limit the flexibility of dealers in negotiations. 11. Financial community generators of wastepaper and some government agencies must retain the material temporarily. 12. Management decisions to dispose of wastes by incineration are often difficult to reverse.
Effect on Recycle Rate	Major constraining effects on recycling of paper.
Remedial Actions Considered	1. Develop incentives to attract more and better labor and management level personnel. 2. Develop improved cleaning processes and/or markets for wastes generated in the process of cleaning paperstock by users. 3. Compile accurate figures on comparative costs of using virgin versus secondary fibers. 4. Consider the possibility of multiple mergers of relatively small dealer/processor organizations into fewer large firms which are likely to have greater bargaining power and greater overall capabilities. 5. Consider initiation of industrial engineering studies aimed at optimizing the handling and processing of wastepaper and paperstock.

TABLE 33. EVALUATION OF GENERAL PROBLEMS RELATED TO RECYCLING OF PAPER

	Criteria and Scores			Total Score
	Solution of Problem Will Improve Environment	Solution of Problem Will Conserve Natural Resources	Realistic Solution Can Be Found	
(Maximum Possible Score)	(10)	(5)	(5)	(20)
Relatively declining demand for products made from paperstock	10	5	5	20
Erratic demand for paperstock	10	3	4	17
Lack of new products made from paperstock	10	3	2	15
Increasing contaminants	9	3	1	13
High costs of transportation	6	2	4	12
Operational problems	5	4	1	10

Source: Judgments of Battelle project team with concurrence of NASMI Commodity Committee, April, 1971.

in this area. In selecting the recommended actions, qualitative consideration was given to criteria such as (a) the importance of the action to solving the problem, (b) technical feasibility and overall likelihood of success for the action, (c) benefits to society, and (d) relative magnitude of time and costs to effect solutions.

Problems and Summary of
Recommended Actions

As indicated in Table 33, the following are the three general problem areas having highest priority:

- (1) Relatively declining demand for products made from paperstock
- (2) Erratic demand for paperstock
- (3) Lack of new products made from paperstock.

Table 34 summarizes (a) action recommendations, (b) recommended participants in the actions, and (c) comments on other actions considered relative to these high priority problem areas.

Action recommendations, participants, and comments on other actions considered relative to the following lower priority problem areas are shown in Table 35:

- (4) Increasing contaminants
- (5) High cost of transportation
- (6) Operational problems.

Information summarized in Tables 32, 34, and 35 is discussed and amplified in the following sections.

TABLE 34. HIGH PRIORITY PAPER RECYCLING PROBLEMS AND RECOMMENDED ACTIONS

Problem Area	Relatively Declining Demand for Products Made from Paperstock	Erratic Demand for Paperstock
Action Recommendations	1. Conduct technical research to improve paper, paperboard, and converted products made from paperstock and/or reduce costs. 2. Develop strategies and educational programs to increase acceptance of and remove stigma from products made of paperstock. 3. Push for nondiscriminatory purchase specifications from government agencies and others.	1. Improve methods of compacting, hogging, and pelletizing waste paper and paperstock. 2. Encourage negotiation of longer term contracts for purchase of paperstock.
Recommended Participants in Above Actions ^(a)	1. EPA, PSIA, paper and paperboard producers, API, BRDA, IPC and TAPPI. 2. PSIA and paper and paperboard producers using recycled fibers. 3. NASMI	1. EPA and equipment manufacturers 2. Paperstock dealers and PSIA.
Comments on Other Actions Considered	Efforts to get through legislation providing incentives for combination board producers or tending to restrict use of virgin fibers can be expected to be a controversial matter and therefore early favorable effects can not be determined at this time.	Economic incentive programs to increase warehousing of paperstock by processors and users may prove to be too difficult to administer. Lack of homogeneity of paperstock and difficulty in grading uniformly would tend to make the administration of stockpiling by government quite difficult.

(a) It is suggested that NASMI continue its leading role in recycling, recognizing that other organizations such as Department of Commerce, Council of Environmental Quality, HEW Office of Information, and State, Local, and Federal Legislatures must also be involved.

TABLE 34. HIGH PRIORITY PAPER RECYCLING PROBLEMS AND RECOMMENDED ACTIONS (Continued)

Problem Area	Lack of New Products Made from Paperstock
Action Recommendations	1. Conduct technical and economic research as to feasibility of combining waste paper with textile wastes and other materials to produce new materials or end products. 2. Conduct idea generation session to identify new product possibilities, and screen ideas generated with regard to market opportunities, etc.
Recommended Participants in Above Actions ^(a)	1. EPA, PSIA, API, chemical, textile and other product producers, and contract research organizations. 2. EPA and contract research organizations.
Comments on Other Actions Considered	Investigation of alternative methods of separating paper fibers in paperstock has been a continuing challenge for paper and paperboard producers and their representatives on TAPPI committees.

TABLE 35. LOWER PRIORITY PAPER RECYCLING PROBLEMS AND RECOMMENDED ACTIONS

Problem Area	Increasing Contaminants	High Costs of Transportation
Action Recommendations	1. Develop inks, coatings, adhesives, etc., which do not inhibit recycling for use in printing and conversion of paper and paperboard. 2. Improve techniques for segregation and sorting of waste paper and paperstock at all appropriate levels. 3. Develop improved methods of cleaning and de-inking and/or coping with contaminants at the user level.	1. Encourage establishment of freight rates favorable to expansion of recycling of waste-paper and paperstock. 2. Push for economic incentives to dealers or processors to increase recycling by offsetting the high costs of overseas shipments now restricting exporting. 3. Investigate technical and economic feasibility of producing "market pulp" from paperstock.
Recommended Participants in Above Actions(a)	1. EPA and ink and adhesives manufacturers, etc. 2. EPA, equipment manufacturers and contract research organizations. 3. EPA, PSIA, paper and paperboard producers, API, BRDA and contract research organizations.	1. EPA, NASMI, and paperstock dealers and processors. 2. EPA, NASMI, paperstock dealers and processors. 3. PSIA, EPA, and BRDA.
Comments on Other Actions Considered	Efforts to encourage legislation to penalize producers or users of contaminating materials may be unrewarding. If such legislation were enacted, difficulties in administering and enforcing it would limit its favorable effect on recycling. However, the possibility of such legislation may encourage industry to give priority to other alternatives.	The development of more economical means of transporting waste paper and paperstock may be too large and broad an objective for the paperstock industry alone. Efforts are already being made by others in this general direction.

- (a) It is suggested that NASMI continue its leading role in recycling, recognizing that other organizations such as Department of Commerce, Council of Environmental Quality, HEW Office of Information, and State, Local, and Federal Legislatures must also be involved.

TABLE 35. LOWER PRIORITY PAPER RECYCLING PROBLEMS AND RECOMMENDED ACTIONS (Continued)

Problem Area	Operational Problems
Action Recommendations	1. Develop better cleaning processes and/or conduct programs to identify markets for residual wastes generated in the process of cleaning or deinking paperstock by users; then conduct technical and economic feasibility studies. 2. Assemble reliable bodies of statistical data comparing economics of using secondary fibers and virgin fibers. 3. Conduct industrial engineering studies aimed at optimizing the handling and processing of wastepaper and paperstock.
Recommended Participants in Above Actions(a)	1. PSIA, paper and paperboard producers and contract research organizations. 2. PSIA, combination paperboard producers and other present users of both secondary and virgin fibers. 3. PSIA
Comments on Other Actions Considered	The thought of developing incentives for labor may be too large and broad an objective for the paperstock industry alone. Others in government and other industries are already working on this problem. Their success may prove to be beneficial to the paperstock industry. No actions to attract more management personnel were identified during the study.

Discussion of High Priority Problem Areas
and Recommended Actions

Relatively Declining Demand for Products
Made from Paperstock

The following three factors contribute to the broad problem of relatively declining demand for products made from paperstock:

- (1) Relatively declining demand for combination paperboard, which is a major consumer of paperstock
- (2) Increasing demand for paper and paperboard made from virgin fibers, especially for applications where high strength is required
- (3) Over packaging (use of virgin fiber containers where secondary fiber containers would suffice) to enhance the marketability of products.

All of these factors are interrelated. The trend away from the use of paperstock in paperboard and in major grades of paper is illustrated in Table 17 in this report. This trend is well established and likely to be difficult to reverse.

The position of paper companies integrated backward into pulp producing facilities and woodlands tends to be a further constraint on a major shift back to use of secondary fibers. The position of these producers is strong and appears likely to become stronger, in view of planned capacity increases and improving technology.

The properties of secondary fibers have gained strong acceptance in some applications, but certainly not for all. In contrast, there has been inadequate

demonstration and promotion of the desirability of secondary fibers for appropriate applications.

Overpackaging (or the use of virgin fiber products in applications in which secondary fiber products might be adequate) is both a symptom and a cause of the overall problem--and a result of affluence, psychological factors, and improving economics of virgin paper products, plus good merchandising by virgin fiber product producers.

The problems and factors described above combine to make relatively declining demand a major constraint on efforts to increase recycling of waste paper. Without a corresponding increase in demand, an increase in supply serves merely to depress prices.

Evaluation of Remedial Actions. The following actions were considered as possible solutions to the problem of declining demand for products made from paperstock:

- (1) Improve techniques for making paper, board, and converted products from paperstock so they will be more competitive with those made from virgin fibers
- (2) Develop strategies to increase acceptance of these products
- (3) Develop educational programs to offset the stigma associated with recycled products
- (4) Determine the economic impact and various other impacts of legislation to restrict the use of virgin fibers
- (5) Provide incentives for paper companies to invest in new capacity to use secondary fibers or resume use of idle capacity
- (6) Encourage the government and others to specify products made from recycled paper.

The appearance and physical properties of some grades of paper and board made from secondary fibers are less desirable to users than the corresponding characteristics of competitively priced paper and board made from virgin fibers. On the other hand, improved characteristics and/or economics for products made from secondary fibers could result from research efforts in one or all of the following areas: (a) processing of fibers preparatory to papermaking, (b) the papermaking process itself, and (c) converting operations, such as off-machine coating. Consequently, research to improve techniques for making paper, paperboard, and converted products from secondary fibers appear worth pursuing. Actually, such research represents a continuation and extension of research already being conducted by paperstock users and converters of paperstock products to improve their products.

The development of strategy and educational programs to increase acceptance of products made from recycled paper represents a continuing challenge to marketing and merchandising personnel in integrated mills tied to captive paperstock sources as well as to PSIA. Appeals to public concern with ecology should be more effective than traditional techniques for increasing product acceptance.

Of all the activities considered in response to the general problem of declining demand, activities to encourage government and other influential purchasers to specify products made from recycled paper and board promise the quickest and most dramatic, if not the greatest, results. These activities have already been initiated by NASMI and some results have already been achieved, as indicated earlier in this report. The most immediate impact of these activities will be on demand for recycled paper rather than combination paperboard, since government agencies buy relatively more paper products than paperboard products.

However, government agencies also might be able to encourage the use of secondary fibers in the packaging of items which they buy.

The possible impacts of legislation to restrict use of virgin fibers or to provide incentives for greater use of production capacity for secondary fiber products should be carefully studied before any such legislation is proposed. The total cost to society of second-order and third-order impacts as well as first-order impacts of such legislation should be carefully considered to assure that new problems are not created in an attempt to solve existing problems. Furthermore, any such legislation, which favors one industry group at the expense of another industry group, is likely to be subject to considerable debate before conclusions are reached that are fair to all parties concerned.

Recommended Actions and Participants. It appears that the greatest benefits to recycling will accrue from emphasizing the following activities:

- Technical research to improve products made from paperstock and/or decrease costs
- Development of strategies and educational programs to increase acceptance of products made from paperstock
- Adoption of nondiscriminatory purchasing specifications by government agencies and others.

As already indicated, worthwhile areas for technical research would include:

(a) processing of fibers preparatory to papermaking, (b) the papermaking process, and (c) converting processes. Battelle recommends a close examination of each of these areas to identify specific research possibilities and to select the most promising alternatives. Examples of research that might produce beneficial results include:

- Work to improve cleaning and deinking processes for paperstock
- The development of special papermaking processes to utilize paperstock near sources of supply, such as major metropolitan areas (such mills probably would have relatively small capacities and may use air-forming or low-moisture processes)

- The development of low-cost coatings and/or coating methods that would allow upgrading of the appearance of solid paperboard made from secondary fibers.

Research on papermaking processes is likely to involve higher risk and require a longer time and higher level of funding than research on either fiber preparation or converting. Research on dry-or low-moisture papermaking involves processes that would be more revolutionary than those likely to be considered in fiber preparation and converting areas.

While the major responsibility for technical research to improve characteristics of primary and end products made from paperstock rests with producers of these products, government participation through the medium, for example, of EPA grants would help to expand these efforts. Joint action initiated by producers with organizations such as the American Paper Institute, PSIA, Boxboard Research and Development Association, The Institute of Paper Chemistry, and TAPPI could also result in expanded research efforts.

The development of strategies and educational programs is the responsibility of paper companies, particularly those integrated producers with captive paperstock suppliers and converting operations. However, joint action on such programs with the PSIA also appears feasible.

In the short term, the most promising activity appears to be the encouragement of the government and others to specific paper made using recycled fibers. Such actions can best be taken by NASMI as a continuing public relations effort in conjunction with efforts to increase the recycling of other commodities.

Erratic Demand for Paperstock

A number of related factors contribute to the erratic demand for paperstock. The basic problem and related factors include:

- (1) Paperstock demand fluctuates as demand for paper, board, and/or converted products fluctuates; mill shutdowns in the summer increase the seasonal variations in demand
- (2) Mills are reluctant to carry extensive paperstock inventories
- (3) Paperstock is perishable and hazardous to handle and store
- (4) Space for storage of paperstock is both limited and costly
- (5) Some collectors go out of business when demand is low.

Factors (2) through (4) contribute in the erratic demand and are unfavorable to actions that might otherwise minimize the effects of erratic demand on generators and collectors of wastepaper.

Because of the high seasonality factors in the end products made from paperstock, it is unlikely that demands can be effectively stabilized throughout the year. At best, remedial activities can only be expected to minimize some of the worst effects of the fluctuations in demand for paperstock.

Evaluation of Remedial Actions. The following were identified during the study as actions that might be suitable for minimizing the erratic nature of the demand for paperstock:

- (1) Improve methods of compacting and hogging paperstock so as to conserve storage space
- (2) Investigate techniques for pelletizing wastepaper or paperstock
- (3) Encourage negotiation of longer-term contracts for paperstock
- (4) Provide incentives for increased warehousing by processors and users

(5) Encourage the Government to stockpile paperstock.

The first two activities listed above would be the subject of research and development projects, while several of the remaining activities entail the need for economic research to evaluate the feasibility of the actions.

Improved methods of compacting and hogging wastepaper as well as methods of producing high-density wastepaper pellets would allow storage of greater amounts of wastepaper in a given space, and generally would improve the economics of warehousing paperstock.

The negotiation of longer-term contracts for paperstock would allow collectors as well as generators of wastepaper to plan further ahead and thus somewhat reduce the risks in handling wastepaper or paperstock.

Economic incentive programs to increase warehousing of paperstock by processors and users are likely to face major administrative problems because of the large number of companies that would have to be involved to make such programs effective. A lack of homogeneity in paperstock and problems in grading paperstock uniformly are other obstacles to effect administration of a stockpiling effort.

Recommended Actions and Participants. Consideration of the foregoing alternatives suggests that greatest benefits to recycling would accrue from efforts to:

- Improve methods of compacting, hogging, and pelletizing wastepaper and paperstock
- Encourage negotiation of longer-term contracts for purchase of paperstock.

Equipment manufacturers are the logical ones to take the initiative in developing improved methods of compacting, hogging, and pelletizing, but support from EPA may be necessary to encourage such efforts. Paperstock dealers and PSIA are the

logical parties to undertake efforts to encourage negotiation of longer-term contracts.

Lack of New Products Made from Paperstock

It has been felt by many authorities in the paperstock industry that successful development of new products made from paperstock is the only way to materially increase recycling. Because new product opportunities currently are limited and because demand for paperstock for current applications has an upper limit, oversupplies in bulk grades of paperstock merely add to the solid waste problem.

The need for new products becomes more urgent as existing markets for products made from paperstock decline and supplies of wastepaper increase. Recycling using existing technologies may not be able to absorb increasing quantities of the bulk grades of wastepaper generated. The only major new use for paperstock developed in the past decade has been as raw material for newsprint de-inking mills.

Evaluation of Remedial Actions. The following actions aimed at remedying the lack of new products became apparent during the research program:

- (1) Investigate the possibility of combining bulk wastepaper with waste textiles to produce new materials
- (2) Investigate the possibility of combining wastepaper with lignins or tall oil to produce new materials
- (3) Investigate alternative methods of separating paper fibers in wastepaper
- (4) Screen all new product ideas as to market feasibility before launching extensive technical research.

The combining of textile waste with wastepaper would be highly desirable because success in this effort would contribute to solving two environmental problems simultaneously by using both wastepaper and textile wastes. Possible new products in this area would include industrial wiping rags as well as other product applications for which recently commercialized non-woven fabric technologies are currently competing.

Investigating the possibilities of combining wastepaper with lignins or tall oil is suggested as a starting point of a more broad investigation to determine the feasibility of combining wastepapers with still other materials.

A reasonable way to start such efforts for utilizing wastepaper would be to conduct idea generation sessions aimed at identifying new product possibilities. Such sessions should include persons who are well versed in the chemistry and physical properties of the materials in question. The results of such idea generation sessions should be carefully screened, and market and feasibility investigations should be undertaken for the most promising of the opportunities identified.

Limited idea generation sessions held at Battelle during the study produced candidate applications such as the following:

- Insulation materials
- Paving materials
- Door cores
- Particleboard
- Fuel products (logs, etc.)
- Animal feeds
- Concrete forms
- Concrete underlayers

- Structural members
- Land stabilizers
- Oil slick controls
- Ship canal seepage controls.

An investigation of alternative methods of separating paper fibers in paperstock could be of benefit by producing either higher quality fibers or lower cost fibers than are currently available. The availability of higher quality or lower cost fibers might encourage use of secondary fibers for some applications from which they might otherwise be excluded. Investigations of this type have been carried on in the past by paper and paperboard producers and to date have not been fruitful. However, Special technologies, such as those associated with ultrasonics or lasers, may have application here.

Recommended Actions and Participants. The following appear to be the most promising of the alternatives considered:

- Undertake technical and economic research on the feasibility of combining wastepaper with textile wastes and other materials to produce useful new materials or end products
- Conduct idea generation sessions to identify new product possibilities, screen the ideas generated with regard to market potential, and conduct feasibility studies for most promising opportunities.

Logical organizations to become involved in the first of these two alternatives include EPA; PSIA; API; producers of chemicals, textiles, and other products; and contract research organizations. EPA and contract research organizations are probably the most likely participants in the second of the two alternatives.

Discussion of Lower Priority Problems
and Recommended Actions

Increasing Contaminants

Important aspects of the general problem of increasing contaminants include the following:

- (1) The development and use of new coatings, laminations, adhesives, etc., over recent years have introduced more contaminating elements into paper and paperboard products.
- (2) The high costs of sorting and dependence on hand labor increase the impact of this proliferation of contaminants.
- (3) Most generators are unfamiliar with the problems created for paperstock users by contaminants.
- (4) Most generators have not been motivated to cooperate with the paperstock industry.
- (5) Users of paperstock often impose extraordinary demands on suppliers or question reliability of supplies and the suppliers.

The overriding problem of increasing contaminants in wastepaper is a result of product development efforts over the past two decades by paper product producers, converters, and their suppliers. The high costs of sorting and the dependence on hand labor to remove contaminants from wastepaper tend to compound this problem. The limited cooperation offered by generators stems principally from a lack of interest in the waste business and their unfamiliarity with the needs of the markets for paperstock.

Evaluation of Remedial Actions. Major actions considered during the study as ways of combating the presence of increasing contaminants in paperstock

were:

- (1) Develop inks, coatings, adhesives, etc., which do not inhibit recycling of the paper and board on which they are used
- (2) Improve techniques for segregating wastepaper at the generator level
- (3) Improve techniques for sorting wastepaper at all levels
- (4) Improved methods for cleaning and de-inking at the user level
- (5) Consider legislation to penalize producers or users of contaminating materials.

All but the last of the abovementioned activities would require some type of technical research and development effort. Considering the first alternative, some progress has already been made in developing water soluble materials which do not contaminate wastepaper as seriously as do some of the adhesives and inks more commonly used. However, much more must be done if this constraint is to be minimized. Obviously, the achievement of success in developing non-contaminating products would reduce the urgency of undertaking work on the other alternatives suggested above.

The second through the fourth of the recommended actions would increase the capabilities of the paperstock industry and users to cope with contaminants.

Efforts to encourage legislation that would penalize producers or users of contaminating materials are likely to meet significant resistance and would only tend to increase the cost or decrease the performance of paper and paperboard products if suitable non-contaminating alternatives were not available. If legislation were enacted, difficulties in administering and enforcing it probably

would limit its favorable effect on recycling. However, the possibility of such legislation may encourage industry to give greater emphasis to other alternative actions.

Recommended Actions and Participants. Because it is unlikely that any one of the alternatives just discussed will be completely successful in eliminating the impact of contaminants, it is recommended that all of the following alternatives be pursued:

- Develop inks, coatings, adhesives, etc., which do not inhibit recycling to be used in printing and conversion operations
- Improve the techniques for segregating and sorting wastepaper and paperstock at all appropriate levels
- Develop improved method of cleaning and de-inking and/or coping with the contaminants at the user level.*

The development of products which do not inhibit recycling most logically would be undertaken by producers of the offending inks, adhesives, etc. Because of the urgency of the need, some support for this type of activity by EPA is indicated.

The initiative for developing equipment for segregating and sorting wastepaper logically falls to equipment manufacturers who might draw upon their own research and development capabilities as well as upon outside capabilities. Again, support from EPA would expedite these activities, since equipment manufacturers otherwise might not be sufficiently motivated to undertake such development efforts.

* Actions of this type was previously recommended to help solve the general problem of declining demand because of the relationship between contaminants and product quality, which in turn affects the competitive position of products made from paperstock.

Activities to improve methods of cleaning and de-inking should be continued and expanded by present users of paperstock with inputs from API, BRDA, and PSIA. Again, EPA aid would stimulate such activities. In some cases, paper mills have been able to cope with contamination by introducing additives that conceal or otherwise neutralize the effects of contaminants. Further investigation of this approach is suggested.

High Costs of Transportation

The following problems contribute to the general problem of high transportation costs:

- (1) Low value of wastepaper relative to its bulk and weight
- (2) Location of important wastepaper sources distant from major users
- (3) Variations in local supply/demand situations, which increase the difficulty of establishing broad national policies
- (4) Difficulties in exporting.

The first three of these problems broadly constrain recycling, while the last problem has impact primarily on collectors, dealers, and processors of paperstock. All of these problems relate to the basic problem of the need to move wastepaper and paperstock, commodities with relatively low value in relation to weight and bulk, from points of generation and processing to points where it can be used. Locations of wastepaper sources vary as a function of population and business concentration, while potential users (primarily paper mills) often are located close to sources of virgin raw materials.

Regional differences tended to compound the overriding problem, since these differences increase the difficulty of identifying broad remedial activities that can be undertaken on a nationwide basis.

The "red tape" and delays in making export shipments tend to compound the associated problem of high costs of overseas movement of paperstock.

Evaluation of Remedial Action. The following activities were considered in response to the general problem of high transportation costs:

- (1) Develop more economical means of transporting wastepaper and paperstock
- (2) Consider establishment of freight rates more favorable to shippers of wastepaper and paperstock
- (3) Consider subsidies to dealers or processors to offset high costs of overseas shipments
- (4) Consider feasibility of producing "market pulp" from paperstock.

The need for more economical means of transportation, of course, extends to many other areas in addition to the paperstock industry, and any general satisfaction of this need would be beneficial to the paperstock industry. Some of the actions already recommended to solve the problem of erratic demand, such as developing improved methods of compacting, hogging, and pelletizing wastepaper and paperstock, would also have some benefit in the transportation area, since increasing the density of paperstock would allow more efficient utilization of transportation resources. Also, the development of new paper-making processes that could economically use secondary fibers would allow reduced transportation costs if paper mills using secondary fibers were located near large sources of wastepaper.

The establishment of lower freight rates for wastepaper and paperstock as well as subsidizing overseas shipments should help to increase utilization of solid waste. Actions to improve the economics of exporting could offset some of the difficulties caused by two other problems now seriously constraining recycling -- declining domestic markets and the lack of products made from paperstock. The establishment of strong export markets might also tend to attenuate some of the wide swings that currently occur in demand for paperstock. Of course, shipping wastepaper overseas would improve the global balance of recycling but would not contribute directly to raising the recycling rate in the United States.

Activities aimed at establishing export subsidies and freight rates more favorable to shippers of paperstock are likely to meet resistance. Changes in freight rates and establishment of export subsidies should be preceded by careful analyses and should be made only if these analyses confirm that the desired benefits will be produced at acceptable costs in terms of primary and secondary effects of such changes.

The NASMI Commodity Committee indicated that past attempts to sell market pulp in the United States had not been particularly successful. However, a trade paper article published subsequent to the Commodity Committee meeting suggested that sale of market pulp in the export market might be attractive because of transportation cost savings from the denser bales and because some foreign mills do not have facilities for processing paperstock into suitable pulps.* Consequently, Battelle recommends further investigation of the feasibility of this alternative.

* "Recycling: Movements in Overseas Markets", Fibre Market News, June 2, 1971, p. 6-7.

Recommended Actions and Participants. Actions already recommended to investigate the feasibility of new papermaking processes (to help solve the problem of declining demand) and to develop improved methods of compacting paperstock (as a solution to the problem of erratic demand) could help to reduce transportation costs. In addition, the following actions that could be beneficial to transportation costs are recommended:

- Encourage establishment of freight rates favorable to expansion of recycling of wastepaper and paperstock
- Encourage subsidies to offset the high costs of overseas shipments
- Investigate the technical and economic feasibility of producing market pulp from paperstock.

Activities pointed toward establishment of favorable freight rates and subsidies to dealers for overseas shipments most logically would be conducted by NASMI and paperstock dealers and processors. Any actions of this type should be preceeded by detailed studies that would quantify the costs and benefits of such actions and confirm or refute the desirability of undertaking specific actions. Such studies could be conducted or funded by EPA.

A study of the feasibility of producing market pulp logically should be authorized by PSIA, possibly with support from EPA and/or BRDA.

Operational Problems

A number of the problems constraining recycling may be classified as operational problems of the paperstock industry or the industries using paperstock.

These include:

- (1) Absenteeism and unavailability of labor in many areas at the wage rates usually offered for processing wastepaper
- (2) Environmental pollution resulting from use of paperstock
- (3) Inadequate economic analyses to support substitution of paperstock for virgin fibers
- (4) The poor image of the paperstock industry in the past
- (5) The relatively small size of many organizations in the paperstock industry
- (6) Excessive loss of time by dealers' trucks at generator and user locations
- (7) High cost of baling equipment and related space in paperstock processing operations
- (8) Users appraisals that risks in using paperstock often are high because of limited liability of dealers
- (9) Growing competition for the assistance of charitable organizations that collect wastepaper
- (10) Changing philosophies in user organizations that tend to limit the flexibility of their negotiations with dealers
- (11) Need for temporary retention of wastepaper by some financial organizations and government agencies
- (12) Management decisions (that are often difficult to reverse) to incinerate wastes.

Some of these problems are broad in impact, while others primarily affect the actions and plans of selected generators, dealer/processors, or users.

Considering the problems individually, it becomes apparent that the paperstock industry problem of absenteeism and unavailability of labor is also a problem of many other industries as well. Thus, the solution to this problem may very well hinge on the success of others in industry and in government who are attacking it.

Water pollution can be caused by the residues left after de-inking and otherwise processing paperstock. This problem can be serious to the extent that enforcement of pollution control standards makes it uneconomic for paperstock users to operate. In such situations, the costs to society of the resulting water pollution versus the solid waste problem must be evaluated in the light of various alternatives available.

The lack of adequate comparative figures to support the favorable economics of using paperstock is, to a large degree, a symptom of past apathy on the part of users about this subject. Further, this lack of data reflects the understandable inadequacy of promotional effort, which has been both a cause and a result of the less-than-glamorous image of the wastepaper or paperstock industry in the past.

A prime cause of inadequate promotional and public relations efforts, however, has been the relatively small size of dealer/processor organizations and the resulting fragmentation of their effort.

The image of the paperstock industry has been materially improved in recent years through the conscientious efforts of both the Paperstock Institute of America and the Paperstock Conservation Committee, a division of The American Paper Institute. Over the past year, these efforts have successfully been focused upon an audience that is much more conscious of ecological issues and, therefore, more receptive to such promotion.

Certain other operational problems, such as the unnecessary tieup of dealers' trucks at generators and mills, may be ameliorated to some degree by the strengthening of dealers' bargaining power through merger or some other action. No clear solution is visualized for the problem of limited liability of dealers, as expressed by users. Until wastepaper processing technology improves, paperstock will continue to be an "imperfect" product, so that the liability for all of the risks in its use cannot logically be assumed by the supplying dealers.

Solutions to the remaining operational problems listed, specifically costs of equipment, competition for activities of collectors, changing philosophies and the need for temporary retention of wastepaper by some generators, are not clearly apparent at this time.

Evaluation of Remedial Actions. The following possible actions were suggested or identified in response to the broad family of operational problems constraining recycling:

- (1) Develop incentives to attract more and better labor and management level personnel into the paperstock industry
- (2) Develop improved cleaning processes and/or new uses for the wastes generated in cleaning and de-inking paperstock
- (3) Compile accurate data on the economics of using virgin versus secondary fibers for promising potential secondary fiber applications
- (4) Consider the possibility of merging relatively small dealer/processor organizations into fewer large firms having greater bargaining power and greater capabilities
- (5) Conduct industrial engineering studies aimed at optimizing the handling and processing of wastepaper and paperstock from the time it is generated until the time it is reused.

As previously noted, problems of absenteeism and labor shortages for jobs of low skill are shared with other industries. Aside from undertaking the obvious actions to make such jobs as attractive as possible, the paperstock industry probably must rely on the results of more broad programs being undertaken by others in industry and government. The changes in welfare programs presently under study eventually may have some impact in this area. Recruiting of management level personnel is viewed as an individual company problem, and no appropriate actions by PSIA or EPA to solve this problem were identified during the study.

Research is called for to minimize water or air pollution by wastes generated in cleaning or using paperstock. Also, disposition of unavoidable wastes in a way that they do not add to pollution but instead favorably affect the economics of using paperstock is a highly desirable goal.

The compilation of accurate data on the comparative costs of using virgin and secondary fibers is also highly desirable. Without such information it is difficult for paperstock dealers and processors to direct their marketing efforts and for interested parties to select longer-term research and development efforts leading to greater utilization of paperstock in both current and new applications.

Consideration of the possibility of merging small dealer/processor organizations into larger firms logically should be the responsibility of the particular companies that might be involved in such actions. Merger candidates obviously will want to give careful consideration to their present capabilities as separate organizations versus the combined capabilities resulting from merger, as well as to a large number of other factors.

Conducting industrial engineering studies aimed at optimizing handling and processing of wastepaper and paperstock seems particularly appropriate to some type of central sponsorship in view of the highly fragmented nature of the paperstock industry and the diversity of its sources and the users of paperstock. Few of the participants in the paperstock industry have the resources or coverage to undertake such studies on an individual basis, yet benefits are likely to accrue to society and to the industry from a study to optimize handling and processing of various kinds of paperstock. Any lowering of operating costs could allow lower selling prices (which in turn could stimulate markets) and greater cash flows (which could provide funds for new investments in market development efforts and equipment).

Recommended Actions and Participants. The greatest benefits to recycling appear likely to accrue from the following:

- Develop improved cleaning processes as needed and/or conduct idea generation sessions and programs to identify markets for wastes generated when cleaning or de-inking paperstock; then, conduct feasibility studies for promising applications
- Assemble reliable bodies of data comparing the economics of using secondary and virgin fibers in various applications
- Conduct industrial engineering studies aimed at optimizing the handling and processing of wastepaper and paperstock from the time it is generated until the time it is reused.

Studies to identify and evaluate new markets for wastes generated in processing paperstock logically falls in the province of paper and paperboard producers and possibly also PSIA. Efforts to develop improved cleaning processes have already been discussed as solutions to previously-mentioned problems.

Activities to accumulate comparative costs of using virgin and secondary fibers could be initiated by PSIA but would require close cooperation from appropriate paper and paperboard producers. Paper companies with captive paperstock dealer organizations would be in a particularly good position to participate in such a program. The work would be purely of an internal nature and would involve assembly of data at representative mills in different parts of the country operating under different sets of circumstances.

Industrial engineering studies to optimize handling and processing of wastepaper logically should be initiated by PSIA, possibly with funding by EPA.

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APPENDIX A

NEW GSA DEFINITION FOR RECLAIMED FIBER

Part I

A. Paper, paperboard, and fibrous wastes from factories, retail stores, office buildings, homes, etc., after they have passed through their end-usage as a consumer item including:

- Used corrugated boxes
- Old newspapers
- Old magazines
- Mixed waste paper
- Tabulating
- Used cordage

B. All paper, paperboard, and fibrous wastes that enter and are collected from municipal waste.

Part II

A. Dry paper and paperboard waste generated after completion of the papermaking process* including:

- Envelope cuttings, bindery trimmings and other paper and paperboard waste, resulting from printing, cutting, forming, and other converting operations
- Envelope cuttings, bindery trimmings and other paper and paperboard waste, resulting from printing, cutting, forming, and other converting operations
- Bag, box, and carton manufacturing wastes
- Butt rolls, mill wrappers, and rejected unused stock

* The papermaking process is defined as those manufacturing operations up to and including the cutting and trimming of the paper machine reel into smaller rolls or rough sheets.

B. Finished paper and paperboard from obsolete inventories of paper and paperboard manufacturers, merchants, wholesalers, dealers, printers, converters, or others.

C. Fibrous by-products of harvesting, manufacturing, extractive, or wood-cutting processes, flax straw, linters, bagasse, slash and other forest residues.

D. Waste generated by the conversion of goods made from fibrous materials, i.e., waste rope from cordage manufacture, textile mill waste and cuttings.

E. Fibers recovered from waste water which otherwise would enter the waste stream.

APPENDIX B

ACTIVITIES CONSIDERED TO REDUCE CONSTRAINTS ON RECYCLING

A great many potential activities or actions which might be undertaken in response to problems or factors constraining the recycling of paper were suggested or identified during the literature search, indepth survey, and analysis phases of the study. Clearly, much has been written and many viewpoints have been expressed in industry gatherings as to how recycling might be increased. Further, most people interviewed during the course of the indepth survey were quite articulate in stating their ideas on the subject. Ideas suggested by persons interviewed and ideas identified during the literature search and analysis, along with others advanced in idea generation sessions at Battelle, are presented in this appendix. The proposed actions or activities are classified under one of three general headings:

- (1) Technical research and development
- (2) New product research and development
- (3) Economic and marketing research and development.

The general definitions of each of these headings, and the activities considered under each, are included in the following sections.

Technical Research and Development

The research activities listed hereunder all tend to fall into the general areas of processing of wastepaper and paperstock, production of products presently made from paperstock, or production of end products presently made from materials in which paperstock is used. (It should be noted that by definition paperstock is wastepaper that has been processed to some degree so as to make it suitable for marketing to users.)

Improve the Techniques for Segregation
of Wastepaper at the Generator Level

Segregation means keeping various forms of wastepaper separate at the source so that they do not become mixed. This is now accomplished in establishments of big generators through the medium of vacuum duct systems or in smaller organizations through simple hand segregation activities. If more reliable and less costly means of separating waste paper grades at the generator level can be developed and widely implemented, problems of contamination and the need for subsequent sorting will be minimized.

Improve Techniques for Sorting at
Processor and User Levels

Any technologies that will minimize the need for manual sorting and the continuing need to make decisions will improve the economics of recycling. The need to make decisions, imposed on workers with low levels of intelligence and interests, is one of the principal reasons for the difficulties in maintaining consistency of paperstock quality. Some electromechanical means of separating types of wastepaper in a mixed bale or basket could have broad application.

Develop More Economical Methods of Compacting and
Hogging for Use at the Generator and Processor Levels

The goal should be to make bales at a maximum density -- perhaps several times the density now achieved -- without danger that the bales will break. The obvious merit in developing methods of maximum compaction is the saving in space achieved in storage and in shipment.

Investigate Techniques for Pelletizing Either
Unsorted Wastepaper or High Grades of Paperstock

Some work has already been done in this area, but not with recognizable success. Again, the major benefit of pelletizing lies in saving space.

Develop Means for Producing "Market Pulp" From
Either Unsorted Wastepaper or High Grades of Paperstock

The assumption is that generators or processors, who now only sort, hog, and bale paperstock in a dry form, would engage in the activity of manufacturing pulp by some form of wet process and then market the resulting pulp to users. With the development of the necessary technologies would come some specialization on the part of processors. Processors would tend to make grades of pulp appropriate to different markets that they might serve.

Develop Improved Methods for Cleaning
Paperstock at the Using Mill Level

The freedom of mills to use more contaminated or lower grades of paperstock with less risk would come with improved cleaning methods. The improved cleaning equipment should have the capability to isolate plastics, wet strength paper, carbon papers, hot melts, etc.

Develop Improved Methods of De-Inking Paperstock So There
Are No Evidences of Residual Gray in the Final Furnish

The efforts by Garden State Paper Company in de-inking old news are well known, but further research could be directed toward reducing the cost of news de-inking and improving the appearance of other grades of paper made from de-inked paperstock.

Develop Products Used in Printing or Conversion
of Paper and Paperboard -- Inks, Adhesives, Coatings,
Etc. -- Which Do Not Inhibit Recycling

Efforts are already being made along these lines, but much still remains to be done. If the present forms of such products are modified so they no longer contaminate paperstock, obviously the need for segregation, sorting, and cleaning will be minimized. Any developmental efforts along these lines should take into consideration the continuing need to protect the environment from new forms of pollution. Reportedly, the manufacture of one new water-soluble ink creates an air pollution problem which does not result from manufacture of regular inks.

Investigate Alternative Methods of Separation
of Paper Fibers in Wastepaper

The idea of treating wastepaper with jets of steam, as differentiated from regular pulping methods, has been suggested.

Investigate the Feasibility of Combining Waste
Lignins or Tall Oil Pitch Residues With Wastepaper
So That These Added Materials May Serve Simply as
Binders in the Production of Possible NonAesthetic Products

This thought suggests eliminating the need for breaking wastepaper down into basic fibers, as is done in conventional production of paper and paperboard.

Investigate the Possibility of Combining Nonrecyclable
Textile Wastes With Bulk Grades of Wastepaper to Form
New Types of Products in Web Form with Characteristics Not
Present in Currently Available Grades of Paper or Paperboard

This thought is similar to that expressed above, with the further hope that the portions of cotton or other textile fibers in the unrecyclable textiles would provide the desirable characteristics. Polyester components in such textile wastes could serve as binding agents.

Develop New Techniques for Making Paperboard
From Wastepaper so the Resulting Product Will
Have More of the Practical and Psychological
Advantages of Board Made From Virgin Fibers

This, of course, was the goal of firms like Federal Paper Board Company when the Iverform process was introduced about ten years ago, but more work remains to be done in this area.

Develop Improved Methods of Manufacturing
Folding Cartons and Corrugated Shipping
Containers From Cylinder and Inverform Paperboard

This type of development work may result in such cartons competing on a more favorable basis with those made from foundrinier board, produced from virgin fibers.

New Product Research and Development

The suggested research activities following tend to overlap, to some degree, with some of the activities enumerated in the preceding section. However, the following ideas, for the most part, relate to nonweb products in which wastepaper or paperstock might be incorporated in contrast to the products in web form already described. Also implied in this category of research activity would be efforts to develop lower cost methods of producing existing low-volume products made from wastepaper. It has also been suggested that creative thought be directed toward new products to satisfy new needs which have not existed in the past, but which are emerging now as a result of broad environmental changes. Some of the results of such thinking is apparent in the following list.

Develop New Uses and Markets for the Waste Materials
Generated in the Process of Cleaning Paperstock

While this activity does not involve developing new markets for paperstock, the development of markets for the clays, inks, and other residues resulting from cleaning paperstock will provide revenue or at least reduce the cost of disposal of these residues for paperstock users and thereby make the use of paperstock economically more desirable.

Investigate Possibilities of Increased Use of
Wastepaper for Insulation in Construction

Quantities are already being used by such firms as Hagen Industries, but further research may open opportunities for more favorable competition with other insulating materials.

Develop a Use for Wastepaper as a
Component of Paving Materials

Feasibility should be examined as to the possibility of mixing paperstock with asphalt or concrete or using the material in road bases.

Develop an Economic Door Core
Material From Wastepaper

Such a material might compete with kraft honeycomb.

Develop a Substitute for Particleboard,
Now Made From Wood Chips, for Furniture
and Construction Applications

The material, like particleboard, could be subsequently covered with a plastic laminate.

Investigate Potential Use of Wastepaper as Fuel

The possibility of using wastepaper in fabricated fire place logs has been suggested, but the market does not seem to be large enough to warrant development. Other fuel applications, such as in industrial steam generation, however, can be visualized.

Continue Efforts to Make Wastepaper
Into Some Form of Animal Feed

The Boxboard Research and Development Association has done work along these lines in the past but without real success. The limiting factor, thus far, has been the fact that other forms of feed, like hay, are available at costs well below the cost of collection and conversion of wastepaper into a suitable food product.

Investigate Possibility of Using Paperstock
in Combination With Other Waste Materials
as a Material for Concrete Forms Which Might
be Removed After the Concrete Has Set or be
Left to Deteriorate

Solid fiber materials are now in use for this application, but the development of a cheaper wastepaper-based substitute may be feasible.

Develop a Concrete Underlayer Made From
Wastepaper Combined With Other Waste Materials

If impregnated with water resistant materials, this new product might serve as a substitute for the plastic films currently used in this application.

Develop Structural Members From Wastepaper
Combined With Other Waste Materials

This idea would call for development, as well, of particular shapes of members to provide the necessary strength characteristics.

Investigate Feasibility of Developing Products
Made From Wastepaper Combined With Other Waste
Materials, Possibly Imbedded With Quick Growing
Seed, to Serve as a Land Stabilizer in Areas
Devastated by Strip Mining or Disturbed in the
Course of Highway Construction (North Slope Applications)

Develop Products Made From Wastepaper, With or
Without Other Additives, for Control of Oil Slicks
Resulting From Tanker Collisions or Leaks From
Off-Shore Oil Wells

Investigate Feasibility of Use of Wastepaper as a
Lining to Control Seepage of Pollutants Into Ship
Canals Constructed by the Army Corps of Engineers

Fracturing the "crust" at the bottom of existing waterways often permits the intrusion of contaminants formerly sealed off.

Economic and Marketing Research and Development

While there are many authorities in the field of paper recycling who feel that the only way to increase recycling is to develop new high-volume products, others recognize that increasing the sale of existing products made from paperstock will accomplish the same objective. The activities described hereunder relate to improving the marketing or the economics of paperstock or of products made from paperstock.

Develop Strategies Or Marketing Techniques
Aimed at Increasing Acceptance of Cylinder
Paperboard and Folding Cartons Made From
Cylinder Paperboard

Container Corporation of America has made a good start in this direction by the use of the recycling symbol printed on cartons made from paperstock to call consumers' attention to the fact that these cartons are made from recycled materials. NASMI has developed a symbol, are using it, and encouraging others to adopt it. Other major users of paperstock might need assistance in developing appropriate strategies.

Develop Information Needed for Consumer
and Packager Educational Programs Designed
to Remove the Stigma Associated With the
Use of Recycled Materials

The positive aspects of such programs would be to demonstrate the actual advantages, to individuals, companies, and the public at large, in the use of recycled paper.

Provide Assistance and Supporting Information
Needed to Encourage Government Agencies and
Other Influential Users of Paper Products to
Specify Products Made From Recycled Paper

NASMI has already taken some effective steps in this direction, but further aggressive action is indicated.

Investigate the Possibility of Calling Upon
the Government to Stockpile Wastepaper as it
Stockpiles Agricultural Products in Order to
Control Supply and Demand Fluctuations

Before this can be achieved, however, some evidence of success in improving the compaction and consistency of quality of paperstock must be apparent.

Develop Means of Encouraging Paperstock Users to Warehouse Greater Quantities of Paperstock in Anticipation of Needs in Order to Minimize the Erratic Shifts in Demand Which Presently Exist

Encourage the Negotiation of Longer Term Contracts for Purchase of Paperstock From Dealer/Processors to Minimize Erratic Fluctuations in Paperstock Prices

Develop Incentives for Present Paperstock Users to Invest in Additional Equipment and Provide Increased Capacity to Use Paperstock in the Production of Paperboard and Other Products

According to the most recent API capacity survey, very little new equipment for utilization of wastepaper is now planned by major producers.

Investigate Possibilities of Developing Incentives for Semi-Skilled Labor at Both the Generator and Dealer/Processor Level

One of the problems inhibiting increased recycling is the unavailability of labor to perform the sorting functions required. The economics of wastepaper sorting often do not permit payment of wages much in excess of what workers can get from welfare agencies. Research activities might also be directed toward finding incentives for bringing more young people with management potential into this industry.

Facilitate the Compilation of Accurate Figures
on Costs of Using Virgin Pulp Versus Paperstock

Many users do not maintain such records and, therefore, cannot validly compare the merits of using one raw material versus the other.

Develop More Economical Means of Transporting
Wastepaper Over Both Short and Long Distances

The development of high-density bales is related to this activity. One idea suggested was the possible development of some form of raft, made of wastepaper, which might serve as a means of moving wastepaper over water. The comparison with existing practices of floating pulp logs down rivers was noted.

Investigate the Possibility of Government Subsidies
to Paperstock Dealers to Offset the High Cost of
Ocean Transport of Paperstock

Such actions would be aimed at increasing exports to foreign countries where paperstock is in short supply.

Investigate the Possibility of Special Freight Rates
for Overland Transport of Paperstock by Rail or Truck

Lower rates could encourage movement of paperstock from areas in the United States where large quantities are generated to mill locations in other areas.

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Investigate the Feasibility of Mergers
of Dealer/Processor Organizations

One means of attacking the problem of the small size of many firms in the industry and the fragmentation of the paperstock industry could be considered. This is the possibility of multiple mergers of the relatively small dealer/processor organizations into fewer large firms with greater bargaining power and greater capabilities overall.

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TEXTILE REPORT

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SUMMARY

The primary purpose of this project was to identify the problems and opportunities for increased recycling of waste textiles through the secondary materials industry. The major determinants of the total waste textile problem include the domestic consumption, complexity of fiber systems, scrap generation in various steps of production, markets for waste textiles, and the systems or mechanisms for scrap collection, sorting, and distribution.

The U. S. Textile Industry consumed approximately 10 billion pounds of textile fiber in 1970, and it is anticipated that this will increase to 15 billion pounds by 1980. A major change in fiber composition has occurred since the end of World War II with the development of synthetic noncellulosic fibers. The principal textile fibers consumed in 1970 consisted of cotton, nylon, polyester, rayon, acrylic, cellulose acetate, textile glass, wool, and the polyolefins. Considerable growth is anticipated for all of the synthetic fibers with lesser or even negative growth seen for cotton and wool. Furthermore, the use of 100 percent cotton and wool fabric will decline rapidly as the natural fiber materials are blended with synthetic fibers, especially polyester.

The secondary textile industry is made up of organizations that buy, sort, process, export, and sell a wide variety of waste textile products. Of the total secondary materials industry, textiles is a relatively small part of the total business with about 5 percent of the organizations having more than 10 percent of their business in textiles. However, the importance of the companies handling textile waste should not be underestimated as they are one of the key elements to the potential reuse of billions of pounds of textile waste each year.

Textile waste materials are produced at every stage of textile processing from the harvesting of the cotton boll to the production of apparel, household items, and other manufactured goods. Other waste products are generated as the normal life cycle of a product is completed, and the material is given to a collection agency, sold, or discarded. Figure I illustrates the flow of waste textiles through the secondary dealer into specific end markets. Approximately 1.6 billion pounds of waste textiles are reused each year with another 2.5 billion pounds being dumped or incinerated. These figures were obtained by combining Tariff Commission estimates with data generated in the extensive and intensive surveys conducted as a part of this study. Additional research is recommended to refine these gross figures and to provide a breakdown within selected categories of products and fibers.

The major markets for secondary textile fibers include paper, vulcanized fiber, wool products, wiping cloths, padding and batting, nonwoven fabrics, flock, roofing, and used clothing.

Major problems facing the secondary textile industry and selected solutions to improve the reuse of waste textiles are summarized in Tables I and II.

Each of the problems and research recommendations needs to be considered in the context of the secondary textile industry. The federal, state, and local governments should realize that the secondary materials industry is a major factor in the reduction of solid waste problems on all levels. Legislation, technical developments, and marketing assistance are needed and should be justifiable to help maintain this ecologically important industry.

Table III was developed to establish priorities related to the eight problems described in Tables I and II. The order of priority is dependent on

factors such as environmental improvement, conservation of resources, and the feasibility of finding a realistic solution. The problem of reusing mixed fiber blends is undoubtedly the most critical in recycling waste textiles for the decade of the seventies.

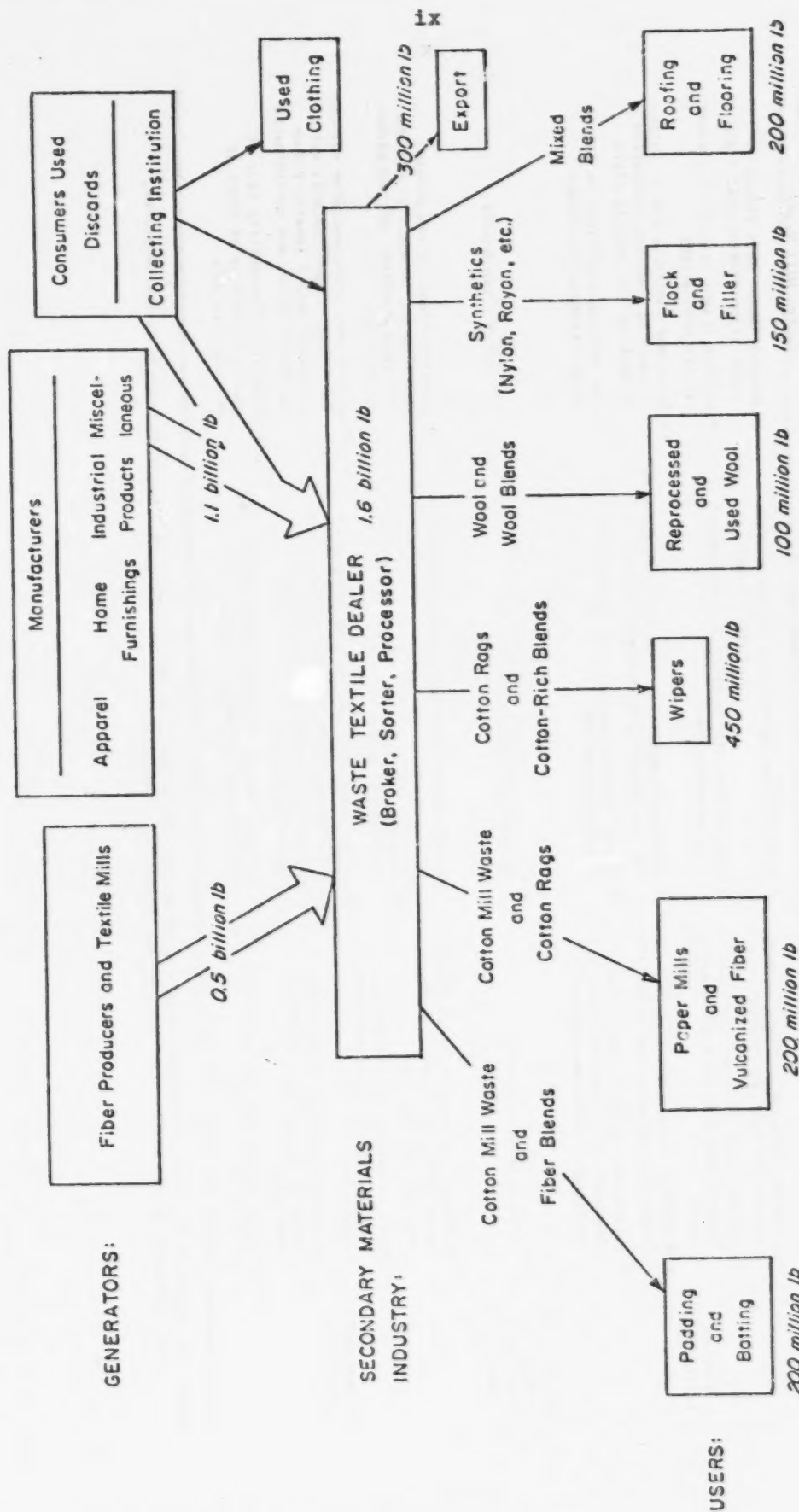


FIGURE 1. WASTE TEXTILE UTILIZATION FLOWS

Sources Estimates on Waste Generators derived from: (a) Old and New Rag Waste: Extensive Survey and Summaries of Trade and Tariff Information, Schedule 3, Vol. 6, and (b) Fiber Producers and Textile Mill Waste: American Textile Manufacturers Institute and Textile Organon, Vol. XII, 1970, p 31.

Estimates on Users were derived primarily from Summaries of Trade and Tariff Information, Schedule 3, Vol. 6, pp 119-124. Adjustments were made to reflect NASMI committee input.

TABLE I. IDENTIFICATION AND ANALYSIS OF SPECIAL PROBLEMS
THAT REDUCE REUSE OF TEXTILE WASTE

Title	Fiber Blend Problem	Wool Problem	Cotton Mill Waste
Problem Definition	- o Dramatic increase in fiber blends, especially polyester-cotton - o Proliferation of other synthetic fibers, new materials and treatments - o Secondary textile fiber markets require relatively pure materials - o Traditional markets such as paper industry and vulcanized fiber are shifting to other raw materials	- o Wool Labeling Act--discriminates against secondary fiber - o Lack of domestic capacity for reprocessing secondary wool - o Increased competition from foreign suppliers in the European reprocessing areas - o Import restrictions on used clothing in developing nations	- o Reduced demand as a result of competition from plastic foams - o Reduced demand because of flammability regulations - o Increased contamination in waste because of improved separation methods at the textile mills - o Poor working conditions in cotton waste reprocessing plants
	5 to 10 billion pounds	200-300 million pounds	100-200 million pounds
Estimate of Volume of Material Involved	- o Determine the quantities of blends being generated as mill waste, new rags and old rags - o Develop methods for separating fiber blends in relatively pure components - o Increase demand for mixed fiber waste by new product and market development - o Provide incentives and protection in exporting of rags	- o Review and modification of Wool Labeling Act - o Increase publicity on the advantages of reprocessed wool - o Define incentives for reestablishment of wool reprocessing industry in U.S. - o Provide incentives and protection in exporting of rags - o Try to have old clothing import regulations modified in developing nations	- o Increase demand by new product development, inexpensive methods for flameproofing, and new market development - o Develop new, less expensive methods for processing cotton mill waste. Processes should greatly reduce air-borne fibers and contaminants - o Reevaluate flammability laws to consider toxicity of fumes as well as burn rate
Recommended Actions	- o Determine the quantities of blends being generated as mill waste, new rags and old rags - o Develop methods for separating fiber blends in relatively pure components - o Increase demand for mixed fiber waste by new product and market development - o Provide incentives and protection in exporting of rags	- o Review and modification of Wool Labeling Act - o Increase publicity on the advantages of reprocessed wool - o Define incentives for reestablishment of wool reprocessing industry in U.S. - o Provide incentives and protection in exporting of rags - o Try to have old clothing import regulations modified in developing nations	- o Increase demand by new product development, inexpensive methods for flameproofing, and new market development - o Develop new, less expensive methods for processing cotton mill waste. Processes should greatly reduce air-borne fibers and contaminants - o Reevaluate flammability laws to consider toxicity of fumes as well as burn rate

Note: The responsibility for recommended actions shown in this table are based on importance of the action, benefit to the taxpayers, and opportunities for NASMI. They are the best judgments of Battelle.

TABLE II. IDENTIFICATION AND ANALYSIS OF GENERAL PROBLEMS THAT AFFECT THE REUSE OF TEXTILE WASTE

Title	Space and Capital Equipment Needs		Increased Labor Costs		Increasing Transportation Costs		Increased Pollution Control		Competition from Virgin Material	
Problem Definition	o Low-density product requires substantial space to operate		o Physical nature of textile waste requires handsorting		o Transportation costs often limit shipment of secondary textiles to processing centers		o Increases cost of operation for processors and marketing outlets		o Renewable materials (wood pulp and cotton linters) are replacing textile waste in selected grades of paper	
	o Low-value product requires inexpensive handling and processing		o Low density and low value add to handling costs		o Transportation costs limit exports to distant countries		o Marginal processors and markets have stopped operations due to increased costs to meet standards		o Virgin wool is being used in place of secondary wool	
	c Aesthetics of secondary fiber plants limit available locations		o Undesirable working conditions limit labor supply and tends to increase costs		o Industrial waste is highly concentrated in selected regions that may be long distance from the converting industry		o There have been decreases in the cost of virgin synthetics		o There have been decreases in the cost of virgin synthetics	
	o Labor supply influences location requirements								o The development and use of disposable nonwoven products competes with wiping rag	
	o High capital investment required									
Recommended Actions	o Key factor is the need for efficient inexpensive equipment and processes to handle low-value, low-density waste to		o Improve available equipment to reduce labor requirements in handling, sorting, cleaning, and other processing steps		o Provide transportation subsidies for recycled materials		o Provide funds for anti-pollution devices and nonpolluting processes for companies using secondary textiles		o Provide price stabilization for specific secondary textile fibers similar to those guaranteed for cotton and wool producers	
	a) reduce labor costs				o Provide demonstration grants to show feasibility of locating user plants near generation centers				o Limit imports of low-cost synthetics that compete with secondary fibers	
	b) maintain good visual appearance		o Provide financial subsidies or rebates to counteract increasing labor costs						o Modify the Wool Labeling Act to encourage the use of secondary wool and other secondary textile fibers	

Note: The responsibility for recommended actions shown in this table are based on importance of the action, benefit to the taxpayers, and opportunities for NASMI. They are the best judgments of Battelle.

INTRODUCTION

In June, 1970, Battelle-Columbus undertook a research program for the National Association of Secondary Material Industries, Inc. (NASMI). This work was carried out under a subcontract from an Office of Solid Waste Management grant to NASMI. This report on textiles is one of a series of eight commodity reports plus a general or summary report.

Background

The Office of Solid Waste Management is responsible for formulating and recommending Federal Government policies in the area of solid waste pollution. This includes pursuing appropriate research to determine the status and problems of solid waste activities, and to develop programs to reduce solid waste pollution.

One approach to the reduction of solid waste pollution is to reclaim waste materials for reuse - the recycling concept. A well established industry--the secondary materials industry--exists to accomplish this recycling. NASMI is the trade association representing the metals, paper, and textiles portion of this industry.

The scrap processors, secondary smelters, and other companies that make up the secondary materials industry have developed effective channels and methods for recycling nearly all waste materials of economic value. These companies have performed their difficult and essential functions well in the traditional economic environment.

More recently additional dimensions have been added to this traditional economic environment. These new dimensions are (1) improvement of the environment in which we live, and (2) increased need for conservation of natural resources. These new dimensions provide new challenges and opportunities for the recycling industry. No longer is economic gain the sole driving force for recycling of waste materials. Social gain has been added in the forms of improved living conditions and preservation of resources for future generations. In an economics-based nation, this creates problems of interpretation and evaluation of noneconomics-based goals and activities.

The purpose of this series of reports is to identify obstacles to the recycling of solid wastes, and to recommend directions for investigation and research to overcome these obstacles.

Objectives

The objective of the study on which this report is based was to identify opportunities for the increased utilization of solid waste. The major subobjectives were:

- (1) To determine the structure and functions of the secondary materials industry, and its relationships to sources of supply and markets
- (2) To identify and evaluate problems of recycling--materials, sources, industry, and markets
- (3) To determine opportunities for increased recycling.

Scope

The major subjects included in the scope of the study are the secondary material industry, the materials it recycles, the sources of solid wastes, and the markets for recycled materials. Activities peripheral to these major subjects are considered where pertinent to recycling.

The materials included in the study are:

Aluminum	Nickel and Nickel Alloys
Copper and Copper Alloys	Precious Metals (Silver and Gold)
Lead	Paper
Zinc	Textiles

Research Methods

The methods and procedures used in the study are discussed under four types of activities. They include (A) literature search, (B) extensive survey, (C) in-depth survey, and (D) analysis and synthesis.

Literature Search

The literature search included reviewing and studying books, Government reports, industry reports, and trade journals covering solid waste handling and problems, recovery and market data, and recycling of valuable materials.

The results of this effort included the accumulation of data and descriptive material, and an organized bibliography dealing with each of the commodities covered in the scope of the study.

Extensive Survey

The extensive survey of the secondary material industry consisted of a mail survey and personal interviews with management personnel of companies involved with the collection, processing, and sale of secondary materials. About 600 responses were received.

The information developed through the extensive survey included dollar sales, tons of major materials handled, types of solid waste processed, sources of materials, investment, equipment and facilities, number of employees, the amount of space used, and the grades and quantities of secondary materials produced.

The data from the extensive survey provided statistical tabulations of the regional distribution of the secondary material industries by type of commodity in terms of numbers of establishments, volume of business, and numbers of employees.

In-depth Survey

The in-depth survey of selected members of the secondary material industries, their suppliers, and the users of their products served to identify the major technical and economic problems facing those companies involved with secondary material utilization. About 200 interviews were completed. Battelle and NASMI commodity specialists jointly selected the companies to be interviewed in depth.

Interview guides for each of the commodities were prepared. The problems and potential solutions for greatest recycling and waste utilization that were developed from the literature search and prior Office of Solid Waste

Management work plus the knowledge of the NASMI commodity specialists provided the basis for designing the interview guide. Sample guides are reproduced in the Appendix.

Analysis and Synthesis

The analysis and synthesis step was concerned with the collation and analysis of data and information derived from both the literature, extensive survey, and in-depth survey. The analysis and synthesis activity covered the following tasks:

- (1) Economic Data on the Secondary Material Industries. The economic data developed through the extensive survey of the secondary material industries were tabulated and analyzed as to the amount and type of solid waste handled and as to operational data such as number of employees, amount of space required, capitalization, and geographic locations.
- (2) Flow Diagrams and Life Cycles. Flow diagrams were developed to indicate the flow of materials from primary production and scrap sources through fabrication. Life cycle estimates of various products were used to develop data on quantities available for possible recycling.
- (3) Demand-Supply Relationships. Estimates were made of future demand and supply levels for secondary materials. The relationship between these data provide an indication of potential surpluses or shortages of recycled materials through 1980.
- (4) Stability of Flow and Consumption. This analysis is closely related to the supply-demand analysis described above and identifies the ability of the various secondary materials to

compete as source materials for manufacturers. A number of factors were examined such as price changes in the secondary materials, the availability of materials, and the effect of sudden changes in the magnitude of demand.

- (5) Direct Impacts of Technological Change. Direct technical and technological factors were examined to determine their effect on rates of processing and recycling. Potential changes that could take place in technology that could decrease or increase the rate of solid waste recovery were examined. This includes the identification of potentially recoverable solid wastes, the problems limiting the recovery to current levels, and the possibilities of technical advances through the use of known technology or through added scientific and engineering research.
- (6) Constraints on Expansion of the Secondary Material Industries. This analysis included consideration of elements critical to expansion of recycling - labor and management availability, laws and regulations, equipment availability, nature of solid waste materials, market needs, etc.
- (7) Potentials for Expansion of the Secondary Material Industries. Based on the constraints identified in the above task, plus examination of various methods for overcoming constraints, this task determined the ability of the secondary material industries to meet new opportunities for recycling.
- (8) Indirect Technological Change. The broad overall technological trends indirectly affecting the secondary material industries were examined, and their probable impacts determined.

Report Outline

The secondary textile industry at present is one of the key elements in the recycling of textile waste products. The primary purpose of this project has been to identify methods to aid recycling of textile fibers through the secondary industry and others. At the present time the secondary textile industry is in an economically depressed state because there exists a number of inherent factors that have inhibited or restricted the recycling of textile waste materials. These factors are both supply oriented and market oriented. For example, the increased proliferation of textile blends has reduced the availability of pure cotton rag waste. Major users of waste cotton have been the paper and vulcanized fiber industries, both of which require high purity cotton fiber for satisfactory processing. Because of contamination with synthetic fibers, a number of mills have changed to other sources of fiber such as wood pulp or cotton linters. As the trend toward fiber blends continues, the markets for pure cotton waste will dwindle along with the supply. The result will be increased use of virgin materials and increased accumulation of waste textile materials.

A simple flow model of waste textiles would consist of goods progressing from (1) the sources of waste (mills, manufacturers, consumers) through the (2) dealer or processor in (3) a final product (wiper, paper, roofing).

In organizing this report, each of these major categories of the recycling process is described in general with special emphasis on problems related to waste utilization. As an introduction to the total problem of textile waste generation, the first section describes the current and future consumption of textiles in the United States in general terms. Indirectly the annual consumption of textile fibers defines the total recycling problem since the production of 1970, for example, results in new waste in 1970 or 1971 and used waste in later years in the form of old clothing, rags, etc. Factors such as new trends in fibers, fiber blends, and end-use products will result in new and challenging recycling problems.

The second section follows the flow of these waste products into the secondary materials industry with an attempt to describe the scope and functions of this group of companies. The third section of the report describes in more detail the sources and types of textile waste. The most obvious conclusion that one comes to in this section is that there is a great variety and complexity of waste products produced.

The fourth section describes in general terms the traditional markets for waste textile products and the existing problems associated with each of these markets. The last two sections review and summarize the recycling problems and provide recommendations for the potential broadening of waste utilization.

THE U. S. TEXTILE INDUSTRY

The United States Textile Industry employs about one million people in 7,500 plants, most of which are located in eastern U.S. The normal annual output is approximately 17 billion square yards of fabric. This is enough to wrap a yard wide strip around the earth nearly 400 times. If an estimated waste factor of 10 percent is applied, the waste generated would wrap the earth 40 times.

In analyzing the present and future quantities of solid waste generated, a number of factors should be considered:

- (1) The present and future domestic consumption of textiles and manufactured textile products
- (2) The type of textile fiber blends used domestically
- (3) The type and form of end products to be produced domestically.

Each of these topics will be discussed in more detail in the following sections.

Present and Future Domestic Production*

In 1970 the consumption of textile fibers in the U.S. was about 10.5 billion pounds with an annual per capita consumption of approximately 50 pounds. Past consumption and future estimates for textile fibers are shown below:

* Most of the tabulated data and conclusions presented in this section were derived from an article by Walter Fedor which appeared in the Chemical and Engineering News of April 20, 1970.

TABLE 1. ESTIMATED TEXTILE FIBER CONSUMPTION 1960-1980

Year	Total Consumption (billions of pounds)	Percent Natural Fiber	Percent Man-Made Fiber
1960	6.5	69	31
1965	8.5	59	41
1970	10.5	39	61
1975	12.5	29	71
1980	15.6	25	75

The major trend indicated in this table is that the consumption of textile fiber will increase about 50 percent in the decade 1970 to 1980. The second and perhaps more alarming fact, with respect to solid waste generation, is the dramatic shift in the production and use of man-made fibers from 1960 to 1980. In the future, a growing percentage of these man-made fibers will be used in blends that are difficult if not impossible to recycle with existing technology.

Textile Fiber Materials and Blends

The type of textile fibers used varies widely depending on the end-use product requirements. The major textile fibers currently include cotton and wool as natural fibers, and nylon, polyester, acrylic, rayon, cellulose acetate, and polyolefins as the major man-made or synthetic fibers. Figure 1 illustrates the relative importance of the major categories of fibers up to about 1970. One very obvious trend is the increasing use of man-made fibers, especially the noncellulosics such as nylon, polyester, and acrylics.

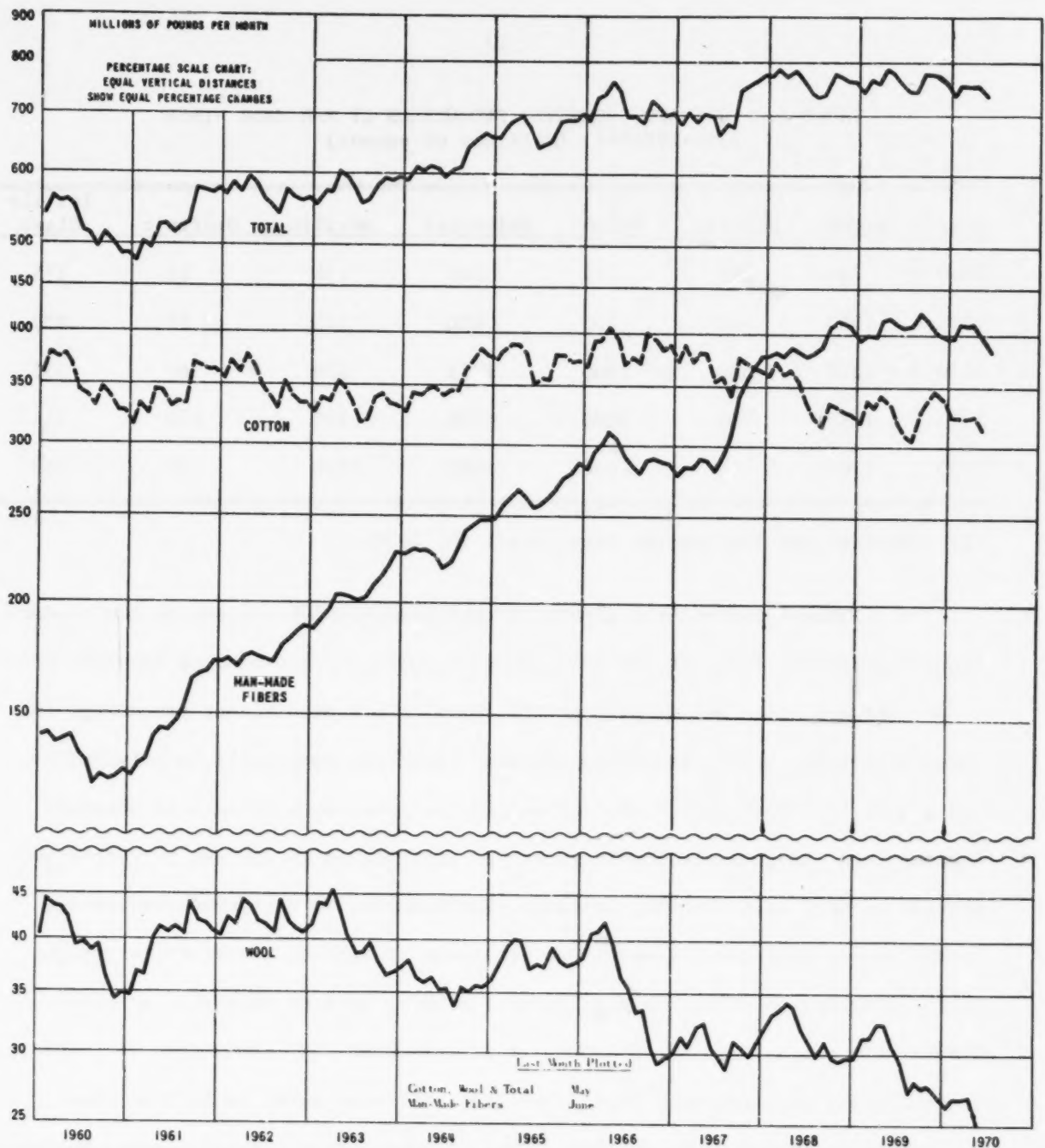


FIGURE 1. U. S. TEXTILE FIBER CONSUMPTION (1960-1970)

Source: Textile Organon, August 1970, p 150

Data are 3-month moving averages, plotted at the middle month. For cotton and wool, consumption means fiber put into process at spinning mills. The man-made fiber data are U.S. producers' domestic shipments plus imports for consumption of (a) rayon staple and rayon+acetate yarn and (b) the noncellulosic fibers. Acetate staple and textile glass fiber are not included.

TABLE 2. ESTIMATED DOMESTIC PRODUCTION OF MAN-MADE FIBER
1960-1980⁽¹⁾ (millions of pounds)

Year	Rayon	Acetate	Nylon	Polyester	Acrylic	Olefinic	Textile Glass
1960	740	290	375	100	150	13	175
1965	1080	445	935	400	370	65	280
1970	1215	580	1565	1365	600	280	525
1975	1450	735	2000	1770	845	450	725
1980	1700	910	2600	2800	1100	790	900

(1) Chemical and Engineering News, April 20, 1970.

Table 2 indicates a growth of approximately 106 percent in the production of polyester fiber in the next 10 years, with a corresponding increase of 67 percent for nylon and 40 percent for rayon. Very significant percentage increases in other synthetic fibers are also expected, especially in polyolefins and glass, but these are on the low end of the scale with respect to absolute consumption. In general, little growth is anticipated in the use of cotton and the use of wool will probably decline. Furthermore, as mentioned previously, future trends indicate a growing use of blends of fibers; therefore, although cotton consumption will remain relatively stable, much of this will go into blends with polyester. For example, it is estimated that production of polyester-cotton blends will increase from 2,360 million linear yards in 1970 to about 9,100 million linear yards in 1980. This is approximately a 300 percent increase in 10 years. This means that less pure cotton will be available for use in the manufacture of rag paper and vulcanized fiber.

The complexity of textile fiber variation is not completely apparent until one becomes aware of the growing proliferation of fiber types and names. Appendix C describes in very brief summary the broad range of textile fiber materials available today. In all probability, there will be new fibers available and in production by 1980.

Textile End Products

The production and use of a wide variety of textile products is the determining factor in total textile fiber consumption and greatly influences the type of fiber to be used. Three very broad textile end-product categories are apparel (39 percent), home furnishings (29 percent), and industrial (19 percent). The remaining 13 percent goes to produce a variety of miscellaneous products. Home furnishings include rugs, carpet, upholstery, draperies, slip covers, and bedding. The relative consumption of textiles in these three categories is shown as follows:

TABLE 3. ESTIMATED CONSUMPTION OF TEXTILE FIBERS BY
END USE (1960-1980)(1) (billions of pounds)

Year	Apparel	Home Furnishings	Industrial	Miscellaneous
1960	2.86	1.30	0.84	1.49
1965	3.56	1.87	1.44	1.62
1970	4.10	3.05	2.00	1.37
1975	4.63	4.00	2.37	1.50
1980	5.30	5.62	3.12	1.56

(1) Chemical and Engineering News, April 20, 1970.

Any changes that occur within each of these major categories will be a major influencing factor with respect to recycling. For example, if the major growth in home furnishings is in carpet and not draperies, then considerably different technology and processes will be required to utilize the old and new waste generated. Estimates indicate, in fact, that one of the major components of household furnishings is carpeting and that shipments are expected to increase 90 percent in the next 10 years (from \$1.75 billion to \$3.26 billion in 1980). Carpets are made mostly of synthetics including nylon, acrylics, polypropylene, and polyester. Carpet construction is further complicated by the use of various backing materials including jute and polypropylene, and also the incorporation of binding adhesives. Similar but less dramatic problems exist in analyzing the apparel market since the relative ratios of hosiery, suits, overcoats, shirts, underwear, etc., will have a major influence on the type of fiber being used and their ease and economics of recycling. In the apparel market, factors such as (1) knitting versus weaving, (2) coated fabrics, (3) impregnated fabrics, (4) bonded textiles, (5) nonwoven fabrics, (6) stretch fabrics, (7) spun-bonded products, and (8) adhesive forming of apparel, will all present new obstacles and challenges to recycling.

THE SECONDARY TEXTILE INDUSTRY

Structure of the Industry

The secondary textile industry is comprised of business organizations that buy, sort, process, export, and sell a wide variety of waste textile products. The characteristics of these organizations vary from the small local rag dealer to sophisticated, highly capitalized regional or international processor-dealers. Of the total membership (approaching 1,000 companies) of The National Association of Secondary Materials Industry, Inc. (NASMI), approximately 5 percent or 50 companies have a significant part (over 10 percent) of their business in textile fibers. Other secondary textile companies may be members of other organizations such as the National Association of Wiping Cloth Manufacturers, the Textile Fiber and By-Products Association, or may not belong to any national association. In any case, these dealers as a group provide the mechanism by which the major portion of secondary textiles are recycled or reused in a variety of end-use products. Figure 2 is a schematic view of the general flow of secondary products from waste generators to secondary materials dealers to the end user or processor.

The remainder of this section on the Secondary Textile Industry will be devoted to discussions of (1) the economic value of the industry, (2) the social benefits of the industry, and (3) the basic functions performed by the industry.

The Economic Value of the Industry

As part of the extensive survey portion of this study, all members of NASMI were polled with respect to both their total operation and to operations related to specific commodity items. The information provided in the extensive survey indicates that the respondents account for the handling of somewhat over

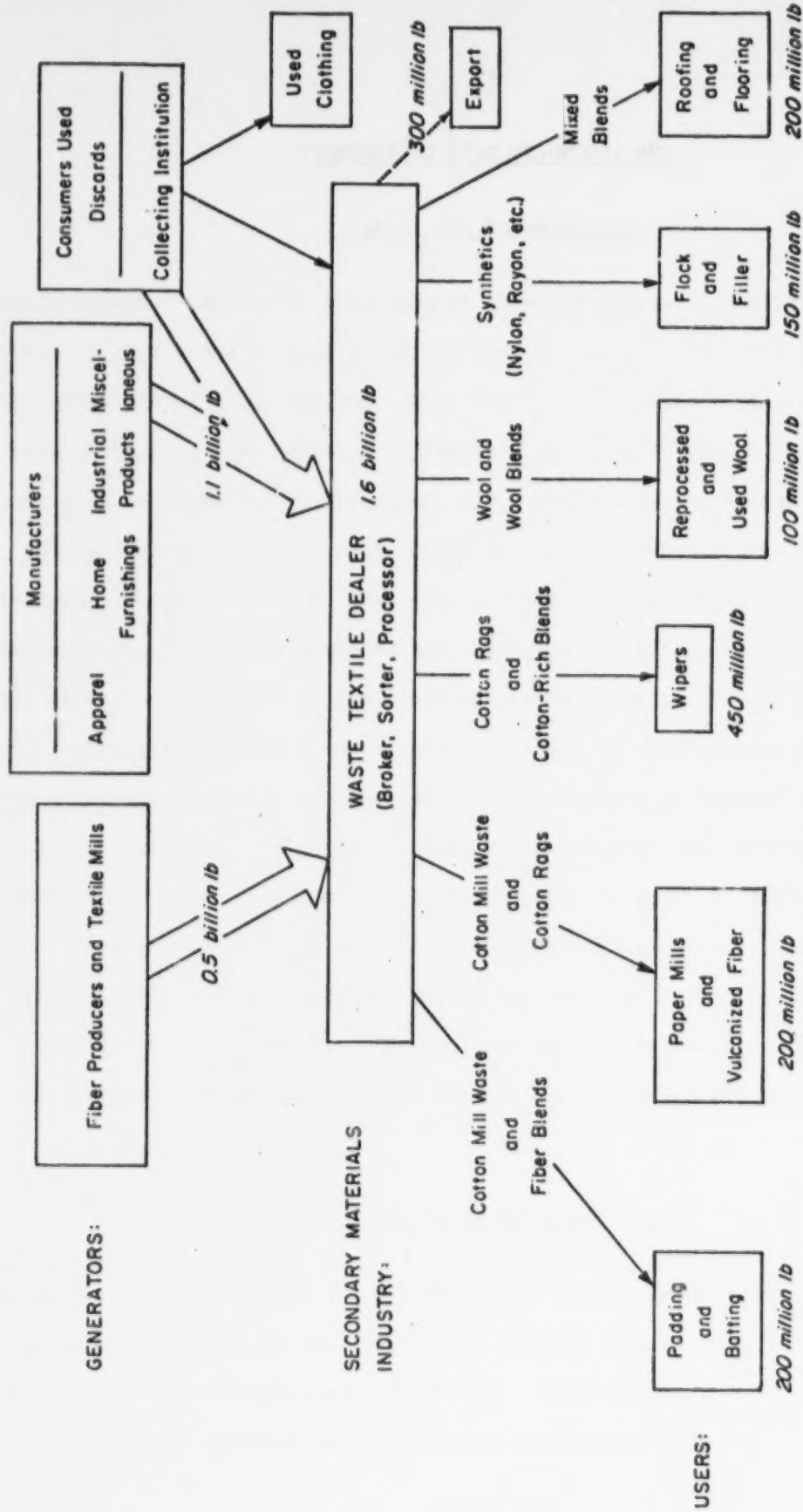


FIGURE 2. WASTE TEXTILE UTILIZATION FLOWS

Sources Estimates on Waste Generators derived from: (a) Old and New Rag Waste: Extensive Survey and Summaries of Trade and Tariff Information, Schedule 3, Vol. 6, and (b) Fiber Producers and Textile Mill Waste: American Textile Manufacturers Institute and Textile Organon, Vol. XII, 1970, p 31.

Estimates on Users were derived primarily from Summaries of Trade and Tariff Information, Schedule 3, Vol. 6, pp 119-124. Adjustments were made to reflect NASMI committee input.

1 billion pounds of new and old rags annually. When this is combined with other available information, it appears that the total amount of secondary textile fiber being reused each year is about 1.6 billion pounds. As shown in Table 4, the value of plant and equipment for individual dealers is in excess of \$250,000 for 60 percent of the industry with an average investment of about \$842,000. Gross sales are less than 3 million dollars for 75 percent of the secondary textile industry companies. Since a large volume of secondary textile products require handsorting, the average investment per employee is small (\$8,900) compared to all commodities combined (about \$25,000/employee).

The results of the extensive survey indicate that about 70 percent of the old and new rags are handled by dealers in three adjacent geographical regions. As shown in Figure 3, the Middle Atlantic region accounts for 36 percent, the South Atlantic 21 percent, and the East North Central 14 percent. These figures do not include producer and mill fiber waste, but do represent about two-thirds of the secondary fiber processed.

Overall, the total capital investment in plant and equipment that currently is available for processing waste textile materials is estimated to be in excess of \$50 million. As will be discussed later in this report, additional investments in the form of new processes and equipment will be required in the future if the industry is to handle increasing quantities of secondary textile fibers.

TABLE 4. GENERAL CLASSIFICATION OF SECONDARY TEXTILE DEALERS
(In Terms of Value of Plant and Equipment
and Gross Sales)

Commodity	Value of Plant and Equipment (1000 of dollars)					
	Less than 250	251-500	501-1000	1001-2000	2001-7000	Over 7,000
Textiles	40.5%	16.7%	21.4%	16.7%	4.8%	0.0%
All categories	33.3%	18.7%	18.5%	13.9%	11.3%	4.3%

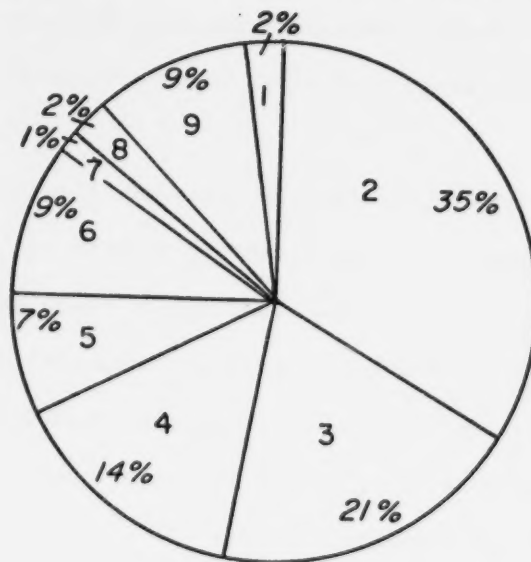
Gross Sales, 1969 (millions of dollars)						
Less than 1.0	1-3	3-5	5-8	8-12	Over 12	
16.3%	57.1%	10.2%	10.2%	6.1%	0.0%	

Waste Textile Industry Averages

Average Investment in Plant and Equipment	\$842,000
Average Number of Employees	95
Average Investment per Employee	\$ 8,900
Approximate Average Investment per Employee for Nontextile Operations	\$ 25,000



1. New England
2. Middle Atlantic
3. South Atlantic
4. East North Central
5. East South Central
6. North West Central
7. West South Central
8. Mountain
9. Pacific (includes Alaska and Hawaii)



Cuttings and Rags

FIGURE 3. GEOGRAPHICAL DISTRIBUTION OF SECONDARY TEXTILE FIBER HANDLED BY DEALERS

Source: Extensive survey of 49 dealers

Social Value of the Industry

The social value of the industry is related to a number of aspects of the business. First is its basic function of recycling waste products. This means that a potentially environmental contaminating material is utilized as an economically valuable raw material. The total value of this recycling process relates to its capacity to reduce solid waste accumulation as well as pollution of air and water and generally to improve the environment. Another major social benefit provided by this industry is the employment of a large number of people with varying levels of skill. Some highly trained individuals are required to sort and grade complex mixtures of rags and fibers. On the other hand, employees of lesser skill may be used to sort and handle easily separated types of materials.

Basic Functions Performed by the Industry

The secondary textile materials industry performs many important functions in the recycling of waste products. In brief summary, these functions include:

- (1) Collection and purchase of waste textiles
- (2) Transportation to the secondary dealers
- (3) General classification according to rough grades
- (4) Individual sorting for specific categories and grades
- (5) Establishment of grades for specific end-uses
- (6) Cutting of select pieces for ease of handling
- (7) Washing and cleaning old rags
- (8) Removal of metal and other contaminants

- (9) Compressing and baling for storage and shipment
- (10) Warehousing
- (11) Selling--domestic and foreign.

This list of functions performed by the industry is not intended to be complete, since tremendous variation exists among companies with respect to the type of waste product being processed, and the potential end-use and final customer for the product.

SOURCES OF SECONDARY TEXTILE FIBERS

General Composition of Secondary Textiles

Secondary textile fibers are produced at every stage of manufacture from the basic cotton boll and synthetic fiber spinning to end-product fabrication. Other waste products are generated as the normal life cycle of a product is completed and the material finally discarded. Figure 4 illustrates the various points in manufacture where waste is generated and also briefly outlines the variety of end products that result from manufacture. Again, the end product fabrication step implies the generation of two additional types of waste--new waste from trimmings and rejects and old waste from product wear or obsolescence.

Complete statistics on the generation of waste at each stage of manufacture generally are not available. In fact, the little attention given by many large companies to waste generation, utilization, and disposal is quite surprising. On the other hand, some companies maintain very thorough records including tonnage generated in a wide variety of grades, selling prices, percent waste discarded, methods of disposal, cost of disposal, etc.

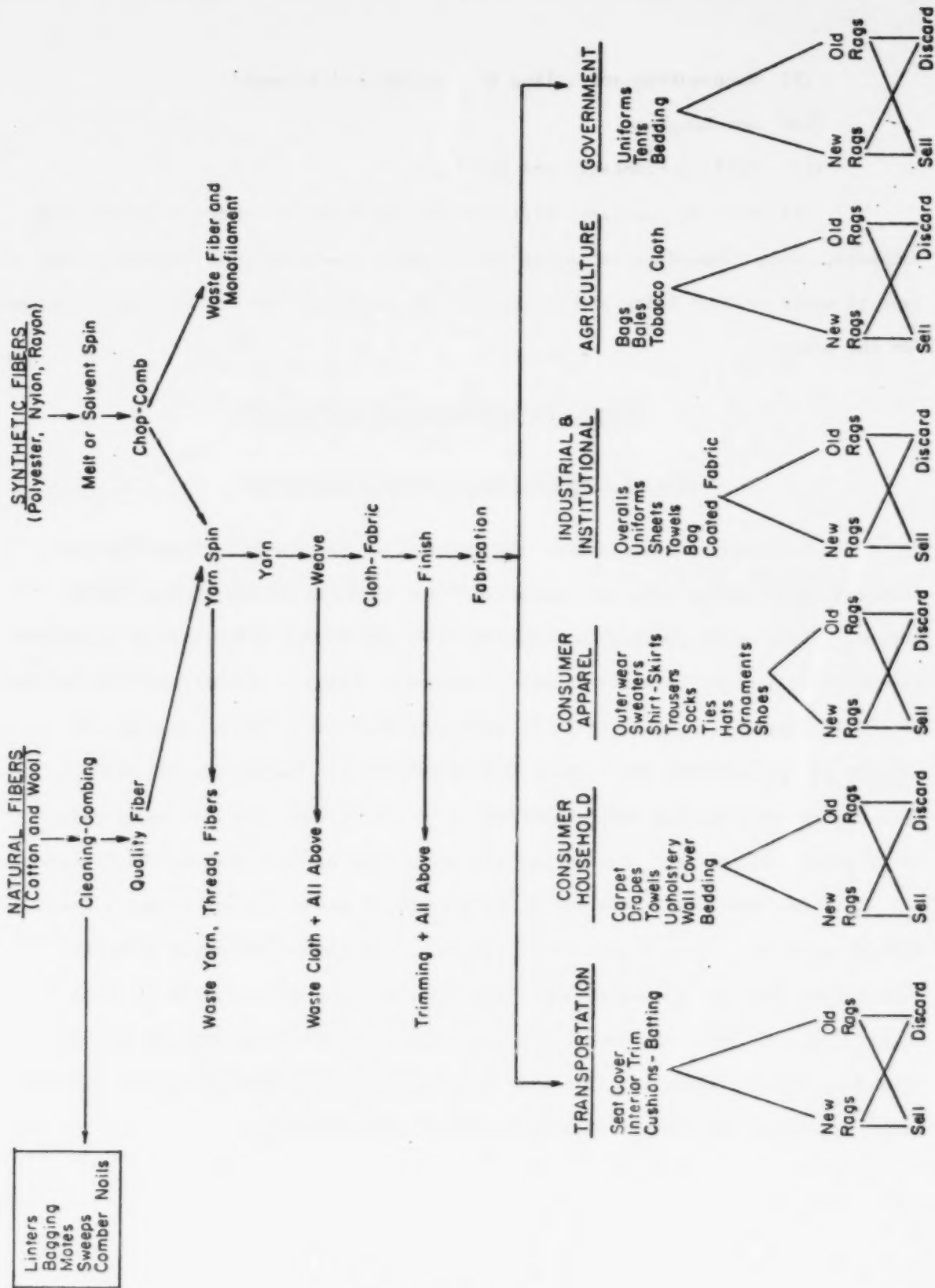


FIGURE 4. TYPICAL FLOW OF TEXTILE FIBERS IN PROCESS AND THE RESULTING GENERATION OF TEXTILE WASTE

Based on a limited number of interviews in the intensive survey, three basic categories of secondary textile fibers were defined as mill waste, fabrication waste, and old rags. These are described briefly as follows.

Mill Waste

Mill waste includes a wide variety of materials ranging from cotton gin waste to trimmings or remnants produced in the weaving or knitting mills. The waste may be in the form of fibers, threads, yarns, monofilament, or fabric composed of synthetic, natural, or blends of materials.

The variety of products contained in this category is demonstrated by comparisons of cotton mill waste and synthetic fiber producers' waste. Cotton mill waste comprises a variety of products including motes, cord fly, cord strips, comber noils, and spinning room sweeps. These various grades and types of waste are generated and collected at different stages of processing. Each category has a different characteristic and economic value.

Synthetic fiber waste is generated at each step of processing from fiber spinning (extrusion) to weaving. For example, some of the grades of rayon waste include bleached open-waste combing, manufacturer's viscose threads, white thread garnetted, rayon staple fiber noils, etc. Other types of synthetic fiber waste (nylon, polyester, acetate, etc.) are generated by the basic fiber producers such as Du Pont, Allied Chemical, and Monsanto, as well as in the textile mills.

The average amount of waste produced in cotton processing is typically about 15 percent on a weight basis. The average waste from processing synthetic fibers is much less. The major use for many of these waste products is for specialty or lower grade textile products. For example, the major portion of

synthetic fiber waste produced by the chemical companies is sold to the garnetting industry. The garnetters process the waste into fibers suitable for yarn spinning, weaving, or knitting. In combination with cotton or wool, the synthetic fiber waste is useful in the fabrication of apparel produced at lower cost than comparable products made from virgin materials.

As a typical "case study", the description and information provided by one integrated textile mill during the intensive survey indicated the following waste problems and practices.

- Cotton waste--weekly consumption of 2500 bales of cotton at 500 lbs/bale. Approximately 14 percent (175,000 lbs/week) of the total becomes waste or by-product in the form of dusthouse, fly, motes, etc. Each of these waste products has a different economic value depending on the level of contamination and fiber characteristics. For example, motes generally will provide a yield of 35 percent usable fiber and 65 percent unusable waste that must be burned or dumped. Of the total 175,000 lbs of by-product, about 10 percent of 17,500 lbs/week is completely useless and must be dumped.
- Synthetic-fiber spinning--total figures were not provided, but it was indicated that only 2 to 3 percent waste is generated, most of which is reused.

- Textile weaving operation--approximately 100,000 lbs of waste are generated each week. Of this, about 25 percent or 25,000 lbs are sold as remnants. The other 75 percent is produced at the finishing plant and is in the form of smaller pieces and of mixed composition. The composition consists of grades such as corduroy, synthetic rag, sheeting rag, mixed colored, etc. Of the 75 percent from the finishing plant, 12 or 13 percent (10,000 lbs/week) is in a mixed color, mixed fiber category under 9 inches in size. The only possible use for this material is in roofing, but due to oversupply in this market, most of the mixed rag grade is dumped or burned.

These figures and data on mill waste generation were generally corroborated during other interviews in the intensive survey.

Fabrication Waste

Another area in which textile wastes are generated is that of fabricating the various textile products such as apparel, home furnishings, and industrial products. For example, apparel fabrication involves placing a number of layers of fabric on a cutting table to prepare component parts for garments. The layout is done with considerable attention given to minimizing the amount of trimming that is produced; however, the clippings still amount to a sizable percentage (about 10 percent) of the fabric consumed. In 1970, with an estimated 4.1 billion pounds of fiber consumed in apparel manufacture, this would result

in 400 million pounds of cuttings and trimmings. A survey* of the apparel industry (based on 5 percent of the industry) indicated that 60 percent of all the apparel waste generated is salvaged. The total volume of waste sent to dealers from apparel manufacture is estimated at 240 million pounds, selling at 1 to 20 cents a pound. The total inherent value of the 400 million pounds is closer to \$80 to \$160 million, based on pure fiber costs of 20 to 40 cents per pound. Of the 160 million pounds of apparel waste that does not go to dealers, 99 percent is hauled and dumped.

Waste generation in the fabrication of household, industrial, and other miscellaneous items is not currently defined. However, based on a 5 percent waste generation factor for manufacturing household goods with 60 percent of this going to dealers, approximately 90 million pounds will enter the recycle stream and 60 million pounds will be dumped. (See Appendix B for details.) Since these three categories of nonapparel fiber manufacturers often utilize complex blends of materials including carpet backing, adhesives, coatings, glass fiber, impregnations, dyes, and finishes, it is expected that less than 10 percent of this total waste is reused.

Old Rags

The third source of waste textiles is the collection of a variety of products completing their normal life cycle. The life cycle may be completed either from wear, obsolescence, or change in styles. The majority of products entering the reuse process are old and discarded garments. Most of these are collected by institutions or agencies such as Goodwill Industries and St. Vincent de Paul Society. Some of the used garments are resold to consumers, while a large

* Source: Unpublished data from Apparel Research Foundation survey.

percentage is sold to the secondary textile dealer for sorting and processing. Old rags represent a wide combination of items including cotton, wool, and synthetic fibers in a variety of forms. To obtain a reasonable degree of homogeneity, the mixed rags must be sorted by hand labor.

A large percentage of the rags sent to the secondary dealer from the collecting agency is in the form of usable clothing. A number of dealers have indicated that the used clothing could be a profitable item for export to underdeveloped countries; however, in many instances protective import tariffs prevent resale of these usable garments.

Statistics on old rag reuse generally are unavailable. The Tariff Commission has total rag reuse (old and new rags) estimated at "more than a billion pounds". However, as mentioned previously and based on a consumption of 3.6 billion pounds of textile fiber in 1965 for apparel, and 1.30 billion pounds of fiber in 1960 for home furnishings, an estimate of 750 million pounds of old rags being reused in 1970 would seem realistic. The other 3 billion pounds of obsolete and worn apparel probably ends up in the municipal waste after being used as wiping cloths and for other miscellaneous reasons around the home.

The National Association of Wiping Cloth Manufacturers estimate they annually process about 900 million pounds of rags with a yield of about 50 percent for usable wipers. What percentage of these rags are old and what percent are new rags is not defined, although a high percentage is probably old rags from charitable institutions.

Actually, more work is required to more accurately establish data on the broad generalization presented here. For example, a weighted-average estimate of textile waste generation would take into account end product differences such

as the relatively high reuse of new cotton rags and virtually zero reuse of waste carpet trimmings. Furthermore, of the total amount of old rags reaching the secondary dealer, a significant portion (20 percent) may be discarded or dumped because of low quality or lack of markets for that grade.

Figure 5, presented earlier in this section of the report, contains approximately 15 to 20 categories or sources of textile waste. This is a gross simplification since the secondary materials industry lists over 100 grades of different textile wastes. Detailed descriptions of waste textile grades are shown in Appendix A.

MARKETS FOR SECONDARY TEXTILE PRODUCTS

The major markets for secondary textile products are shown in the lower portion of Figure 2 and consist of papermaking, vulcanized fiber, wipers, reprocessed wool, roofing, padding and batting, flock and filler, and used clothing. Each of these markets is described briefly in the following sections. The statistics presented were derived primarily from U.S. Tariff Commission data as presented in Summaries of Trade and Tariff Information, Schedule 3, Volume 6, and from NASMI committee members. Appendix B contains details for these and other statistical sources.

Papermaking

Insofar as Western civilization is concerned, paper was originally made from thoroughly disintegrated cellulosic rags. Much of this was, at first, linen, but as the cotton industry developed, this fiber became the principal constituent. In response to the industry's critical shortage of cotton and linen rags, experi-

ments were conducted which led to the use of wood fibers. At the present time, wood pulp is the predominant material and rag stock is used only in those applications where the high strength and durability needed can be obtained solely through its use. Some technological changes, such as the increasing use of microfilm for record-keeping, have brought about a reduction in the demand for rag paper.

Although the total quantity of cellulosic materials consumed by the paper industry has been increasing in recent years, the amount of rags used has been declining. Tariff Commission figures indicate 425 million pounds of cotton rags were consumed by the paper industry in 1967. NASMI estimates consumption in papermaking in 1967 at 62 million pounds and 44 million in 1970. The recent decline in the use of cotton rags in papermaking is due to (1) contamination of cotton with synthetics and (2) competition from cotton linters and cotton mill waste, especially combers. The incentive to shift to cotton linters and comber waste is related to reduced cost and reduced risk of contamination. Paper mills that have continued using cotton rag stock for papermaking rely heavily on their sources of supply to provide a high-quality waste material.

In general, most paper manufacturers studied preferred to cook their own rag pulp since they already have the equipment and they can maintain better control. Some companies buy part of their rag pulp from processors, such as the Cheney Company, that specialize in the preparation of cotton rag pulp.

A potentially major factor in this field are processes under development by the large textile manufacturers. For example, Burlington Mills is currently supplying a cotton pulp that apparently works satisfactorily in a number of paper mill operations. This process was supposedly developed to produce high-quality cotton pulp from polyester-cotton blends. However, it is currently

speculated that the starting material is probably cotton comber and the process will not be used with polyester-cotton blends as a starting material while comber is in good supply.

An important aspect of the Burlington operation is that they seem to be selling direct to the paper companies with a reported capacity for 26 million pounds of pulp per year. This could have a serious impact on secondary textile dealers that specialize in sale of high-quality cotton rags to the paper industry. Another ecologically important factor of this concept is that centralized processing of rag pulp might simplify waste disposal that currently results in many mills from the caustic cooking of rags. With increasing legislation and control of industrial pollution, centralization of pulping with efficient effluent treatment might provide a means for continued use of cotton pulp in the form of rags or mill waste.

Vulcanized Fiber

Vulcanized fiber is made by preparing suitable paper, stacking it to the desired thickness, and treating it with zinc chloride to produce a gelatinous condition. In the gelatinous stage, all of the layers fuse into one homogeneous mass. It is then necessary to leach out the zinc chloride, allowing the cellulose to reharden. The resulting product has been popular for a long time, being very strong and durable. It is a familiar component of insulating separators for train rails, foot lockers, instrument cases, and similar applications.

Despite its interesting structural properties, vulcanized fiber materials have certain shortcomings that prevent its widespread use relative to synthetic polymers, and its recent growth history is not impressive. The production of vulcanized fiber was estimated at 50 million pounds in 1968,

indicating that the maximum consumption of rags would be approximately the same. Actually, in recent years the industry has been converting from all cotton rags to linters and high-grade wood pulp due to the presence of synthetics in the rags. It was reported during this study that one major company, out of a total of six, had converted entirely to linters and wood pulp. More details on the declining use of cotton rags are presented in other sections of this report.

Roofing and Flooring

Another market area for secondary textiles, somewhat related to the previous two, is in the manufacture of saturating felts for roofing and linoleum type flooring. In making these materials, rags are processed much as they are for paper. They then are made into a loosely bound web of a more open structure than that usually found in paper. This open web is then saturated with tar or asphalt, and sprinkled with finely divided mineral granules. In the case of flooring, the felt is used as a substrate, which is impregnated with a layer of resinous or polymeric material.

Because this felt must be low in cost and is surrounded by the resinous material, this market is generally considered an outlet for offgrade rags, especially fiber blends or dark colors. Generally, rag dealers use this as an outlet for those types of rags, such as ones of high synthetic content, which are not applicable to other areas. There are indications, at least in some cases, that this practice is unwise. One roofing plant official interviewed said that the presence of synthetic fibers causes weak spots in roofing, ultimately leading to leaks. This plant had changed completely to the use of wood pulp. At the same plant, another official claimed that the move to wood pulp had been prompted

entirely by price. In any case, this company had removed their rag preparation equipment, and could not go back without considerable expense.

At another mill the manager said that they were using rag stock, were quite satisfied with the general situation and, in fact, were benefiting from the lowered prices of rags. This could either indicate prejudice on the part of the one mill, or lower quality control on the part of the other.

The overall market for rags in roofing and flooring was estimated at 200 million pounds in 1967 by the Tariff Commission. More recent estimates would probably be placed at the same level, although this market fluctuates widely with trends in the construction industry. The total dollar value of textiles used has probably declined substantially with the overall decline in prices of waste rags and competition from wood pulp.

Wiping Cloths

The market for wiping cloths is probably the largest single market for old and new rags. Generally, the trade considers a wiping rag as 18 x 18 inches or larger. For some uses, however, rags as small as 12 x 12 inches are acceptable. The major requirement of a wiper other than size is absorbency. The favored material is cotton which has high surface energy and readily absorbs greases, paints, dyes, solvents, and aqueous-based fluids. Total annual consumption of waste textiles as wiping cloth is estimated at 450 million pounds (1969). Actually, more rags could be consumed by this market, but there is an insufficient supply of waste material generated to meet the size and absorbency requirements.

The majority of wiping cloths are produced from old rags. They are sorted, cut to remove buttons and other contaminants as required, washed thoroughly and sterilized. They are graded and bagged or baled and sold

principally to industry and government agencies. One of the largest single customers is the Armed Forces who purchase through a central procurement facility.

Reprocessed Textile Products

This section is concerned with the recycling of waste textile materials into apparel, blankets or other textile products that might also use virgin or top-quality textile fibers. One major use of textile waste fiber is the internal recycling of waste generated in the various steps of textile manufacturing. Since these materials are handled internally, statistics are not generally available and would not be very meaningful if available.

The most significant recycling of waste textiles through external routes involves the reuse of wool fibers in the woolen system. The market for wool rags is well established, although the demand and prices are subject to considerable variation. Wool rag classifications as established by the National Association of Secondary Material Industry through its Wool Stock Institute include: mixed wool knits, rough mixed khaki, and mixed flannels, to name just a few. A more complete listing and description of various grades are included in Appendix A.

The consumption of wool rags and trimmings in the U.S. is estimated at 100 million pounds annually (1967). Furthermore, of the total export of rags in 1967 (342 million pounds), approximately 28 percent or nearly another 100 million pounds were wool. The principal export market for wool has traditionally been Italy where the rags are reprocessed into new woolen fabrics.

Flock and Filler

Flock and filler are both supplied in chopped fiber form. In the process of flocking, the chopped fibers are applied to the surface of another material to provide a textured or plush appearance and feel. Fillers are used internally in plastic materials to increase tensile strength and impact resistance and, in some cases, to reduce cost.

Flock is made from two types of fibers: virgin and waste. Virgin fibers are required when the application is such that the length must be uniform. This is precision cutting. For those applications where uniform fiber length is not necessary, and for fillers, random cutting is acceptable and waste may be used. Random cut flock traditionally has been made from cotton. In recent times, nylon has become more popular.

Applications using precision-cut (virgin) flock have been increasing rapidly. At the same time, several of the large markets for random cut fillers have been lost because of modern technological developments. An example of this is in phonograph records, which were once made of filled shellac. They are now made of unfilled vinyl, and are being partially supplanted by magnetic tape.

As in most industries, the trend has been toward higher speed production. In order to do this, uniformity of material becomes of increasing importance. Flock manufacturers would like to have the waste that they use carefully segregated and labeled as to composition. They would also like it to be separated and labeled by denier. They feel that the mills and the dealers should be made more conscious of their needs in these respects.

A possible development that might increase the use of chopped secondary fiber would be the development of a large-scale, wet-laid nonwoven fabric industry. This would be based on nonwoven materials made from a slurry on a paper machine. While the major component of these materials would be wood pulp, it has been found desirable to include synthetic fibers (5 to 25 percent) for increased tensile and tear strength. Material costs are a major factor in this industry since the final fabric will sell for 6 to 15 cents per square yard. It has been suggested that blended fibers from secondary textile materials, being quite low in cost, could be cut to suitable size by chopped fiber manufacturers and still be inexpensive enough to be used in nonwoven structures.

Batting and Padding*

Batting, padding, and upholstery industries are major outlets for cotton mill waste and man-made fiber waste. In 1963 these industries consumed about 185 million pounds of soft cotton waste, 195 million pounds of cotton linters, 14 million pounds of hard cotton waste, and over 115 million pounds of synthetic and other unclassified waste.

Since 1954 there has been a continual decline in the number of firms supplying these industries. For example, from 1954 to 1963 the number of firms decreased from about 200 to about 180--and the number of employees decreased from 9100 to 6900.

Most firms engaged in manufacturing padding and upholstery filling have relatively few employees with about 80 percent having less than 50 employees each (1963). Although considerable increases in production were reported from 1954

* Source of statistics in this section is U.S. Department of Agriculture, Economic Research Service Bulletin 334, "Marketing and Utilization of Cotton Mill Waste", Washington, D.C., March, 1967.

to 1963, more recently the use of waste textiles in padding and upholstery has been declining as urethane foams increase in use.

Used Clothing

On the generation end of the cycle, used clothing originates largely in charitable institutions, where it has been donated by a consumer. Examples of the types of organizations involved are: the Salvation Army, St. Vincent De Paul, and Goodwill Industries. The donated clothing is sorted by the charitable organization and those items which they consider suitable for resale are separated. The remainder is sold to a dealer as rags.

Either the institution or the rag dealer sometimes will sell a part of the usable clothing to a dealer in used clothing. For the most part, the dealer is an exporter, who ships to another dealer in an underdeveloped country.

A high proportion of the rags being processed in the United States into wiping cloths and other less valuable applications are, in fact, usable clothing. If a sufficient export market were available, much of this could be sold at higher prices. In particular, some of the items that have very low value as rags have this low value because they are made of complex materials such as polyester-cotton blends which, in fact, may enhance their value as clothing. The suggestion has frequently been made, that Government action to encourage the sale of used clothing in developing countries would benefit both the local population and the secondary clothing

industry. NASMI has suggested this, and the Department of Commerce has recommended it to the State Department. Apparently nothing further has developed.

MAJOR OBSTACLES TO REUSE OF TEXTILE WASTE

Having previously described briefly the background of the U.S. textile industry and the secondary textile industry, this section deals primarily with the major problems that inhibit or prevent reuse of textile waste materials. Each of the problems or obstacles described is exceedingly complex since it invariably extends over various aspects of society, commerce, government, and the secondary materials industry. Since the problems are complex--simple, uncomplicated solutions are not readily available. In fact, in most cases each problem area will need additional research for more complete definition with a systematic search for realistic solutions. However, the first step in solving any problem is its identification as a problem and, second, the development of a preliminary base of information to describe the extent of the problem. Therefore, the primary purpose of this section is to identify and describe in limited detail the major obstacles to the reuse of textile waste. The following section will provide suggestions for further research that hopefully will lead to workable, realistic solutions.

This section has arbitrarily been divided into two basic subsections. The first subsection describes a number of special problems that are related to three specific waste products. The second section deals more with general problems that embrace many aspects of the total waste industry. The various problems identified are summarized in Tables 5 and 6 along with selected solutions to these problems. Details of these problems are presented in the following sections of

TABLE 5. IDENTIFICATION AND ANALYSIS OF SPECIAL PROBLEMS THAT REDUCE REUSE OF TEXTILE WASTE

Title	Fiber Blend Problem	Wool Problem	Cotton Mill Waste
Problem Definition	- o Dramatic increase in fiber blends, especially polyester-cotton - o Proliferation of other synthetic fibers, new materials and treatments - o Secondary textile fiber markets require relatively pure materials - o Traditional markets such as paper industry and vulcanized fiber are shifting to other raw materials	- o Wool Labeling Act--discriminates against secondary fiber - o Lack of domestic capacity for reprocessing secondary wool - o Increased competition from foreign suppliers in the European reprocessing areas - o Import restrictions on used clothing in developing nations	- o Reduced demand as a result of competition from plastic foams - o Reduced demand because of flammability regulations - o Increased contamination in waste because of improved separation methods at the textile mills - o Poor working conditions in cotton waste reprocessing plants
Estimate of Volume of Material Involved	5 to 10 billion pounds	200-300 million pounds	100-200 million pounds
Recommended Actions	- o Determine the quantities of blends being generated as mill waste, new rags and old rags - o Develop methods for separating fiber blends in relatively pure components - o Increase demand for mixed fiber waste by new product and market development - o Provide incentives and protection in exporting of rags	- o Review and modification of Wool Labeling Act - o Increase publicity on the advantages of reprocessed wool - o Define incentives for reestablishment of wool reprocessing industry in U.S. - o Provide incentives and protection in exporting of rags - o Try to have old clothing import regulations modified in developing nations	- o Increase demand by new product development, inexpensive methods for flameproofing, and new market development - o Develop new, less expensive methods for processing cotton mill waste. Processes should greatly reduce air-borne fibers and contaminants - o Reevaluate flammability laws to consider toxicity of fumes as well as burn rate

Note: The responsibility for recommended actions shown in this table are based on importance of the action, benefit to the taxpayers, and opportunities for NASHI. They are the best judgments of Battelle.

TABLE 6. IDENTIFICATION AND ANALYSIS OF GENERAL PROBLEMS
THAT AFFECT THE REUSE OF TEXTILE WASTE

Title	Space and Capital Equipment Needs		Increased Labor Costs		Increasing Transportation Costs		Increased Pollution Control		Competition from Virgin Material	
Problem Definition	o Low-density product requires substantial space to operate		o Physical nature of textile waste requires handsorting		o Transportation costs often limit shipment of secondary textiles to processing centers		o Increases cost of operation for processors and marketing outlets		o Renewable materials (wood pulp and cotton linters) are replacing textile waste in selected grades of paper	
	o Low-value product requires inexpensive handling and processing		o Low density and low value add to handling costs		o Transportation costs limit exports to distant countries		o Marginal processors and marketers have stopped operations due to increased costs to meet standards		o Virgin wool is being used in place of secondary wool	
	o Aesthetics of secondary fiber plants limit available locations		o Undesirable working conditions limit labor supply and tends to increase costs		o Industrial waste is highly concentrated in selected regions that may be long distance from the converting industry				o There have been decreases in the cost of virgin synthetics	
	o Labor supply influences location requirements								o The development and use of disposable nonwoven products competes with wiping rags	
	o High capital investment required									
Recommended Actions	o Key factor is the need for efficient inexpensive equipment and processes to handle low-value, low-density waste to		o Improve available equipment to reduce labor requirements in handling, sorting, cleaning, and other processing steps		o Provide transportation subsidies for recycled materials		o Provide funds for anti-pollution devices and nonpolluting processes for companies using secondary textiles		o Provide price stabilization for specific secondary textile fibers similar to those guaranteed for cotton and wool producers	
	a) reduce labor costs		o Provide financial subsidies or rebates to counteract increasing labor costs		o Provide demonstration grants to show feasibility of locating user plants near generation centers				o Limit imports of low-cost synthetics that compete with secondary fibers	
	b) maintain good visual appearance								o Modify the Wool Labeling Act to encourage the use of secondary wool and other secondary textile fibers	
	c) reduce storage and processing space requirements									

Note: The responsibility for recommended actions shown in this table are based on importance of the action, benefit to the taxpayers, and opportunities for NASHI. They are the best judgments of Battelle.

the text with specific recommendations being presented in the last section of this report. Table 7 summarizes eight basic problems with respect to improvement of the environment, conservation of resources, and feasibility of finding a realistic solution to the problem. The fiber blend problem has the highest priority for future work.

Special Obstacles to Reuse

There are a number of special problems or obstacles related to the reuse of textile waste products that are either very broad in nature or so basic to the total waste utilization problem that they require special attention. As one might expect, in analyzing these problems the major symptom that appears is one of oversupply or depressed prices, or both. The three general groups of materials that are causing major concern in the secondary materials industry are (1) fiber blends, (2) wool, and (3) cotton mill waste. Each of these special problems is described separately as follows.

The Fiber-Blend Problem

Prior to World War II, the number of types of textile fibers available were rather limited, so separation and reuse was not a major problem. In 1942, the primary commercial textile fibers consisted of cotton, wool, rayon, cellulose acetate, and some nylon and silk. Table 2, presented previously, demonstrates very dramatically the rapid increase in both the number of types of fibers since World War II and also the greatly increased volume of production. Much of the increase in types and volume of new fibers being produced is related to the growing trend for polyester-cotton blends and polyester-wool blends. However, more complex combinations of materials exist in carpeting or auto upholstery

TABLE 7. SUMMARY TABLE ON TEXTILE WASTE REUSE

Problem Definition	Solution of Problem Will Improve Environment* (0-10 scale)	Solution of Problem Will Conserve Natural Resources (0-5 scale)	Realistic Solution Can be Found (0-5 scale)	Total
Fiber Blend Problem	7	5	3	15
Wool Problem	2	1	4	7
Cotton Mill Waste	2	1	2	5
Space and Capital Equipment Needs	4	3	2	9
Increased Labor Costs	4	3	2	9
Increasing Transpor- tation Costs	4	3	2	9
Increased Pollution Control Requirements	2	1	2	5
Competition from Virgin Material	6	4	2	12

* Relative only to textiles and not total solid waste.

and padding where fibers are joined with adhesives, foams, backing materials, and plastic films. Little or none of these highly complex composite products can be reused at the current level of technology.

The increasing trend toward use of cotton-polyester blends and wool-polyester blends probably represents the major problem of the 1970's, since they are not only generally unusable in themselves, but they tend to become mixed with other usable waste textiles and thereby reduce the economic value of the total waste supply. Because of the rapidly growing volume of material composed of polyester-cotton blends, the remainder of this section will be devoted to further discussion of this problem.

Historically, the three major markets for cotton were (1) rag paper, (2) vulcanized fiber, and (3) wiping cloths. Since rag paper and vulcanized fiber manufacture have similar manufacturing and materials requirements, these can be discussed together as a group.

Paper and Vulcanized Fiber. A number of subsidiary problems have been caused by the proliferation of fiber blends in the waste textile area. First, the purity of a given shipment of cotton waste becomes more doubtful every year as polyester-cotton blending increases. In the manufacture of rag paper, the allowable maximum level of synthetic fiber contamination is 1 to 2 percent, although in some cases none is allowed. The limit of allowable contamination for use in vulcanized fiber is even less.

This increase in blending has directly reduced the amount of pure cotton available which then requires more sorting or greater control to maintain quality. Other factors of concern are the greater number of rejected bales and a final higher price of cotton to the paper mills.

The basic decrease in the supply of pure cotton rags is apparent from a number of trends. One is a shift from rag pulp to cotton linters or 100 percent wood pulp. This means that virgin materials are now being used to replace secondary textile waste. The reasons for this shift are basically economic, and under current conditions rag pulp costs about 25 cents/pound to produce while linters and wood pulp are approximately 15 and 10 cents, respectively. Furthermore, one accidental use of a contaminated batch of cotton rag can cost a paper mill or a vulcanized fiber plant thousands of dollars. Of the three major vulcanized fiber plants operating in the U.S., one has changed over to linters and pulp entirely, while the other two are seriously considering a similar change.

Another factor in the cotton rag business as related to papermaking is the possible development of rag pulping facilities at the textile mill level. During a number of interviews in the intensive survey, the Burlington Mills process for separating cotton from polyester-cotton blends was mentioned. Exact confirmation of the details of this process has not been possible. Some sources indicated that the process may eventually be capable of handling polyester blends, but the major consensus is that the process currently uses only cotton comb waste.

The eventual total development of this process or similar processes would help to resolve the supply situation for the paper mills, but this again would possibly be substituting a virgin by-product fiber for a waste fiber. Furthermore, continued development of similar processes could have adverse effects on the traditional secondary materials industry.

Wiping Cloths. The growth in polyester-cotton blends has not as yet had any great impact on the wiping cloth business for a number of reasons. First, wipers are to a large extent recovered from old rags that have been through the normal wear cycle. Also, the functional use of wipers is not as sensitive to small percentages of polyester fiber, although combinations of 50:50 (polyester: cotton) or 65:35 do not have satisfactory absorption characteristics to be a good wiper. Third, wipers typically require a rag of fairly large dimensions so hand-sorting can be used effectively to remove rags that contain large percentages of synthetic fiber. Overall, the wiper portion of the secondary textile industry is by far the most profitable segment of the industry. A number of dealers have commented that this is the one part of the business that supports many of the other more marginal areas. The future for wipers continues to appear promising; however, the continued growth of fiber blending undoubtedly will reduce the percentage of usable rags and decrease secondary industry profits.

The Cotton Producers' Institute and other concerned groups have developed interesting methods for providing permanent press characteristics to cotton with some of the desirable effects of cotton-polyester blends. However, in the foreseeable future it seems unlikely that these modified cotton products will have much of an impact on the growth of polyester-cotton blends. Furthermore, some of the cotton treatments produce undesirable effects that limit their use in papermaking or cloth wipers.

In summary, the amount of cotton-polyester waste that is generated is a substantial fraction of the total waste problem and is increasing. Markets for the blends are small and unstable. Secondary dealers, in most cases, buy mixed fiber blends at minimum prices in order to maintain their relationship with primary generators. Frequently the dealer ends up disposing of the fiber

blend by burning or dumping. Identification of new markets for fiber blends would greatly reduce the overall textile waste problem. Also, development of methods to separate or improve the absorbency of fiber blends might open new markets or expand existing ones.

The Wool Problem

Probably the second most severe problem facing the secondary textile industry in 1971 is the accumulation of waste wool products. The wool problem is extremely complex because there are many subsidiary factors involved. The major market for wool rags is in Europe where waste wool is reprocessed and converted back into fabric. Traditionally, mixed grades of wool have been used in roofing felts, but this market is quite depressed because of oversupply and trends toward use of other fiber sources. Some of the reasons behind the oversupply of wool include:

- (1) The Wool Labeling Act of 1939
- (2) Lack of domestic wool reprocessing capacity
- (3) Competition from European rag sources
- (4) Foreign restrictions on used clothing imports.

The Wool Labeling Act of 1939. The Wool Products Labeling Act of 1939 was passed, apparently for several reasons. One was to benefit the wool growers, by making a clear distinction between their product and wool derived from secondary sources. A second, more openly avowed, purpose was to protect the public from being sold a supposedly inferior product.

The first of these purposes might be questioned when it is pointed out that only a fraction of the American wool demand is grown in this country. The remainder must be filled with imported and secondary wool.

In regard to the second of the stated purposes, it is probably true that there were cases in which product quality was not carefully controlled and attempts were made to deceive or cheat the consumer. However, there are authorities in the use of wool who claim that wool is not inferior or reduced in quality after it has been processed and used. Certainly, it must be agreed that some fiber shortening and fibrillation takes place. Since wool comes in a great variety of grades, it seems likely that reprocessing would merely transfer the wool involved into a slightly lower grade. Dealers and users of secondary wool generally believe that fabrics made from secondary wool and from primary wool cannot be differentiated by trained wool experts. It appears, therefore, that there is no discernible difference between new and reprocessed wool that is not commensurate with the differences between grades in new wool.

There is a psychological factor, however, with reused wool which causes the labeling to have a discriminatory effect. This takes the form of an instinctive feeling that the secondary fibers as well as the resulting apparel are inferior or unclean, despite the fact that the fibers have been carded, scoured, and cleaned thoroughly (prior to respinning) which would almost certainly remove any actual soil and provide a high degree of sterilization. The doubtful validity of this criticism is pointed up when the condition of even the dirtiest old rag is compared with that of freshly shorn wool. Although the consumer's image of a sheep may be a clean, white lamb, in actual fact a sheep is extremely dirty.

The wool not only picks up all types of dirt from the surroundings, but also soaks up and attracts natural oils and perspiration (suint) from the sheep as well as excretory remnants.

Lack of Domestic Wool Reprocessing Capacity. Partially because of the Wool Labeling restrictions and the stigma associated with reused wool, the wool reprocessing industry in the U.S. has dwindled to where it is currently an insignificant factor in the total U.S. textile industry. Although a considerable amount of reprocessed wool is used by the American consumer, a major share of this is reprocessed in foreign countries, especially Italy. Major reasons for the foreign exodus of the wool reprocessing industry were the Wool Labeling Act and the labor-intensive nature of wool reprocessing. As mentioned previously, the Wool Labeling Act applies to both domestic and foreign-made products. However, since it is virtually impossible to tell the difference between a virgin fiber and a reprocessed fiber, it is normal practice for imported reprocessed wool to be identified only as wool. Reprocessed or used wool produced in the U.S. must be marked accordingly.

Reprocessing of wool from new or old rags into high-quality fabric requires considerable handsorting of materials for texture and color. In fact, a wide variety of colors and color combinations are produced in the Italian industry by physical blending of separate color batches. Some of this blending skill is still found in the few woolen reprocessing mills remaining in New England and other parts of the U.S.

Competition from European Rag Sources. The fact that the major portion of wool reprocessing is located in Europe results in many export oriented problems for the secondary textile industry. For example, because of growing affluence

in Europe, more rags are now generated overseas against which U.S. rags must compete. Second, European governments, especially the British, provide economic incentives and payment protection for the export of rags and other materials. This means that the U.S. secondary dealers operate at a higher risk with a lower return. Finally, increased labor and transportation costs for domestic and foreign shipments act as additional barriers for U.S. waste textile exports.

Foreign Restrictions of Used Clothing Imports. Actually, much of the old woolen rags collected in the U.S. are in the form that they could be used by large segments of the world's population as clothing. However, many of the undeveloped and developing nations have import restrictions on clothing in order to encourage the establishment of domestic industries. Many of the secondary textile dealers interviewed indicated that, to a large extent, these import restrictions are effective only in depriving the population masses of low-cost secondary apparel. This problem is indeed highly complicated since the establishment of import quotas or other restrictions by foreign nations are generally outside the control of the secondary materials dealer, or the U.S. government. However, it appears that some effort should be taken by the governments concerned to permit the movement of low-cost usable clothing to the needy people of the world.

Wool Problem Summary. It generally appears that the migration of the wool reprocessing industry to Europe is not favorable in the long run for the utilization of U.S. generated secondary wool. It also seems that the Wool Labeling Act in its current form serves no useful purpose other than to encourage the use of virgin wool fibers, most of which are imported from outside the U.S. Finally, if nothing is done to encourage a resurgence in the domestic wool

reprocessing industry, then perhaps action should be taken to encourage increased waste wool exports. Increased wool exporting would have a three-way effect of reducing textile waste accumulation, aid the secondary textile industry, and improve the U.S. balance of payments.

The Cotton Mill Waste Problem

Cotton mill waste consists of various grades of fibrous products accumulated or collected at different steps in cotton textile processing. These are designated by terms such as motes, dusthouse, card fly, cord strips, comber noils, clearer, sweeps, threads, and rags. Average annual production of cotton mill waste probably exceeds 250 million pounds. The dollar value of this waste has decreased dramatically in the past 5 years because of price reductions. For example, American Textile Manufacturers Institute statistics indicate the average price per pound of waste was 5.4 cents in 1969 as compared to 9.0 cents in 1965. Detailed figures for each grade are shown in Appendix A.

Overall problems of this segment of the secondary textile waste industry are due to a number of factors including (1) loss of markets in padding and batting resulting in oversupply and (2) increased cost of recovering fiber.

Padding and Batting Markets. Probably the major deterrent to the reuse of cotton mill waste in the 1970's will be a decline in the traditional padding markets as a result of competition from urethane foams. Within a relatively few years, the automotive cushioning market has changed almost 100 percent from the use of cotton batting to polyurethane foam. The average consumption of textile waste was estimated at about 30 pounds per automobile, totalling something in excess of 200 million pounds a year. The primary incentive for the change from cotton to foams is related to the light weight of foams, ease of handling,

and lower labor costs to the automobile manufacturer. The Textile Fiber and By-Products Association has attempted to reverse the trend to foams by emphasizing the supposedly toxic nature of fumes generated by burning urethane foam. However, little or no success has been achieved to promote safety legislation in this area. In fact, in some ways cotton waste is at a disadvantage under existing flammability laws since cotton will support combustion, although it does not produce highly toxic fumes.

The general burn characteristics of cotton may also be a disadvantage in other traditional markets, such as home furnishing and bedding, since there is a movement toward flammability legislation in these areas. Realistically, all factors such as burn rate and smoke toxicity should be considered in legislation designed to protect the safety of the consumer.

Increased Cost of Recovering Fibers. Another major factor in the reuse of cotton mill waste is the relatively high cost of recovering the usable fiber fraction. In recent years the cotton cleaning processes have been upgraded considerably, resulting in lower-grade cotton by-products. This, of course, means that greater volumes of by-product must be processed to acquire a given grade of usable fiber. Also, the general increased affluence, minimum wages, and welfare benefits that affect the U.S. labor force have increased costs of separation.

One other major factor that may be looked on indirectly as a cost is the very poor working conditions that are normally present in cotton by-product processing plants. Environmental conditions of extreme heat, high humidity, low temperatures, and fiber-contaminated air all contribute to limiting the available labor supply and to increasing costs.

General Obstacles to Reuse

Space and Capital Equipment Needs

A textile recycling facility shares with the other elements of the secondary materials industry a poor image as an urban neighbor. The industry deals with a low unit value material, which cannot usually justify the cost of maintaining a highly attractive plant or investments in equipment.

The fiber industries, textiles and paper, by their very nature are forced to maintain enclosed facilities, but they are also susceptible to wind-blown spills and the like during in- and outbound handling.

Secondary materials facilities are, therefore, usually located in areas that are relatively low in value, widely separated from all but the most inferior housing areas, and generally quite exposed to any urban renewal type programs. After the area has been taken over for urban renewal or new freeways, or similar purposes, the dealer is then faced with choosing a new location. All of the available area has, however, been zoned in such a way as to discourage low-value, unsightly establishments, which many authorities consider to include secondary materials facilities. The dealer, therefore, has great difficulty in relocating, and only rarely can establish himself in a new spot attractive enough to encourage the maintenance of an efficient plant. There also are tax and licensing situations adverse to a dealer.

As has been noted, this same public aversion also is a factor in marketing recycled products. The public impression is of salvaged junk, and therefore inferior and somehow tainted.

Increased Labor Costs

Although increasing labor costs have been mentioned in a number of specific cases in this report, the total adverse effects on the waste textile industry are serious enough to warrant special attention. Increased labor costs resulting from minimum wage legislation and general increased welfare benefits probably affect the textile waste reuse more than many other types of waste commodities. The great effect of increased labor costs on textiles is due to the high labor requirements involved in sorting, handling, and processing the hundreds of grades of secondary textile products. Furthermore, the bulky nature of textiles results in a high handling cost per unit weight. In many cases the working conditions in the plants are such that only the most destitute worker will consider this for employment. Part of the solution to these problems includes increased capitalization to reduce labor requirements and/or improve working conditions. However, most of the secondary textile dealers are reluctant to invest in equipment when markets are declining, or the return on investment is minimal or highly risky. Furthermore, in many instances, equipment or processes are not currently available and may involve high risk development.

Increased Transportation Costs

In many ways increased transportation costs have a similar and markedly more severe impact on textile waste reuse when compared with many other waste commodities. The very nature of waste textiles which include low value, high bulk, and tremendous variation, presents a serious disadvantage in shipment. In many cases, what were once marginal sources of waste, or marginal dealers or markets, are no longer operating. This results in an even greater distance

between various elements of the reuse process with even greater increases in transportation costs. The final result is a decrease in reuse of secondary textile materials and increased accumulation of solid waste residues.

Increased Pollution Control Requirements

Increasing trends in the control requirements of water, air, and solid waste pollution will have a variety of effects on recycling of textile waste materials.

Where certain waste materials are currently disposed of by burning or by landfill, legislation to control these practices will tend to increase recycling. However, where environmental legislation tends to increase the cost of operating a textile waste processing plant, paper mill, or vulcanized fiber plant, the economic incentives for textile reuse may be eliminated. For example, a number of paper mills have changed from using rag pulp to virgin wood pulp or cotton linters to avoid the contamination of streams by bleach, caustic, and dyes resulting from the processing of waste cotton denim. Part of the solution to this problem may be the establishment of grants or subsidies to help support the installation of selected pollution abatement equipment that allows for reuse of secondary materials.

Competition from Virgin Materials

The primary incentive for using secondary textile fibers traditionally has been the availability of quality materials at low cost. In recent years, the uniformity and reliability of certain grades of secondary fiber has decreased as a result of fiber and other chemical contaminants being present. The major incentive to the use of virgin materials is uniformity and reliability of product.

As mentioned previously, virgin materials are currently competing successfully with secondary fibers in the production of paper, vulcanized fiber, wool processing, and upholstery cushioning for a variety of reasons. The one area that seems to justify special attention in this study is the fairly recent development and growth of disposable nonwoven fabrics. There is no question that disposal of these products, whether in a sewer system, incinerator, or landfill, presents problems. Furthermore, future anticipated use in hospitals, schools, hotels, airplanes, restaurants, factories, and military establishments indicates added pressure for conventional means of disposal. For example, the sale of disposable sheets, pillowcases, gowns, and masks to hospitals was around \$125 million in 1967. The American Hospital Association estimates that this would increase to about \$300 million in 1970.

The industrial market uses a wide variety of products made from nonwoven fabrics. Industrial wipers alone represent a market that is currently estimated at over \$200 million a year.

These recent developments and trends in disposable nonwoven fabrics could represent an outlet for low-cost secondary fibers; however, to date virtually all nonwoven structures are produced from virgin materials. Furthermore, these virgin products offer strong competition for secondary textile wipers in many markets.

Since the sale of rag wipers is one of the most profitable segments of the secondary materials industry, decreases in the size or elimination of this market could have a severe impact on the continued existence of marginal or even profitable operations.

RESEARCH RECOMMENDATIONS

The major output of this study is the identification of the problems or obstacles to recycling waste textile fiber as described in the previous section. The objective of this current section is to outline suggested future research that might, in a relatively short time, result in increased reuse of textile fiber waste. Future research recommendations, for the most part, are directed toward specific problem areas, although in some cases the recommended work might be general in nature and could be related to several specific problems.

Research on Fiber Blends

Three possible alternatives to the reuse of fiber blends include (1) reuse as a fabric or yarn, (2) reuse as a fiber, or (3) reuse as a chemical. It would be advisable to attack this major problem with a broad technical-economic research program. This program would include (1) the identification of the major sources of waste fiber blends, (2) determining specific characteristics of different blends, (3) exploring the feasibility of automatically separating fabrics, fibers, or chemicals from the blends, and (4) identification of markets for the resulting products of separation. The technical and economic portions of the study should be carefully balanced so there is close interaction between these two phases of research. Initially, it appears that the major research input would be technical in order to test a number of research ideas on separation.

Fiber Separation

The physical separation of cotton-polyester blends or wool-polyester blends into pure components would greatly increase the value of these materials. The possibility of achieving a physical separation on mixed fibers of this type seems to be remote, although little or no information was available on any attempts made to produce fiber separation. Intuitively, it seems possible that techniques using electrostatic energy, differential densities, or differential solubilities might be investigated.

Chemical Separation

Chemical separation of various portions of fiber blends might be achieved by selective degradation of one of the fiber components or perhaps hydrolysis of both components followed by a physical separation.

One example of this type of process that is currently being explored in industry involves the selective hydrolysis of the polyester fiber in cotton-polyester blends. The details of this process are not as yet known, but it apparently involves hydrolysis of the polyester in order to recover the terephthalic acid and relatively pure cotton fiber. The terephthalic acid or its derivatives are eventually used in the polymerization of new polyester resin. Depending on the complexity of the final process and the characteristics of the resulting products, it is conceivable that members of the secondary materials industry would incorporate processes such as this into their operations. However, at this stage of development little is known about the economics or technology involved in this type of process.

Another process that might be applicable to fiber blend separation is photodegradation of cellulose, using inorganic salts as catalysts. This method is currently under investigation at the Gillette Company Research Institute.

Selective solvent separation of fiber blend components is also technically feasible, although cotton, polyester, and wool are not readily soluble in common solvents.

Market Selection

Potential markets for the products achieved by separation or purification will depend greatly on their nature and physical properties. Certainly the traditional markets, such as papermaking for cotton and reprocessed fabric for wool, would be prime candidates. Other new markets may become apparent as new products are developed or become potentially possible. For example, a cotton residue containing 5 to 10 percent polyester fiber might be marketable as a non-woven wiper raw material, providing the absorbency and cost of the fiber is satisfactory to meet the demands of this market.

The possible use of secondary wool in cigarette filters might be considered. CSIRO, the Australian research organization, has reported that wool fiber filters are about twice as effective in the removal of tobacco tars as those made from cellulose acetate. It has been pointed out that wool being a protein will react with the components in smoke that are most apt to react with the cilia of the lungs that are also proteinaceous.

Research on Wool

Problems inherent in the reuse of secondary wool are probably less technical than political or market oriented. As pointed out previously, one major factor in the loss of domestic capacity and relocation in Europe was the Wool Labeling Act. Therefore, research recommended to aid reuse of secondary wool might include:

- Investigation of the need to repeal or amend the Wool Labeling Act. Perhaps a better method for defining wool quality would be by fiber length, strength, color, and denier, rather than by source or history.
- Investigation of the means to stimulate consumer acceptance of secondary wool products. This might involve the development of advertising to reverse consumer bias against reprocessed wool. Increased demand for secondary wool products might provide the incentive for resurgence of the wool reprocessing industry in the U.S. In the past, the wool reprocessing industry was ranked as a critical element during wartime.
- Investigation of the possibility of changing government procurement procedures to require use of secondary wool in military uniforms, blankets, or accessories. This would alter some existing standards that presently call for virgin wool.

- Investigation of the possible establishment of Federal incentives to aid in exporting new or old wool rags. This might include recommendations for prepayment or guaranteed payment for shipments to developing nations. Consideration should be given to subsidy of transportation to foreign nations to minimize solid waste accumulation.
- Investigation of the need and possible mechanism for greater export of secondary clothing to undeveloped countries. This may require long-term negotiations between the U.S. Government and the governments of underdeveloped nations to reduce or eliminate protective tariffs on used clothing.
- Initiation of selective studies on the possible use of wool protein or amino acids in nonfiber or nontextile uses. For example, enzymatic hydrolysis of wool might produce a relatively low-cost source of amino acids for food or food supplements.

Cotton Mill Waste

The two major problems that inhibit the reuse of cotton mill waste are: (1) loss of existing markets in padding and batting, and (2) increased cost to recover the fiber portion of the waste. Future work directed to overcome these obstacles might include:

- A detailed reevaluation of the cotton mill waste industry.
- In March, 1967, a fairly optimistic report was issued by the U.S. Department of Agriculture Economic Research Service

(ERS-334) on "Marketing and Utilization of Cotton Mill Waste".

One major conclusion described in the Summary of this report was that, "Use of mill waste is expected to continue to increase as technology broadens outlets. Some of this increase will likely occur through more in-mill use, while the remainder will occur as greater consumption by existing waste manufacturers." It appears that very dramatic changes have occurred in this field during the past 5 years since the price of mill waste has decreased about one-half, and new research should be conducted to clarify these changes.

- Continued investigation of new markets for cotton mill waste in papermaking, plastic reinforcing, foam supplements, artificial leather, ceiling tile, floor covering, and soil conditioners. Specific characteristics of each grade of cotton mill waste need to be defined and compared to newer types of mill waste including synthetic fibers and fiber blends.
- Investigation of means to improve selected properties of cotton and other mill wastes. For example, if fire resistance legislation is truly a threat to continued use of cotton mill waste in upholstery and bedding, then the development of inexpensive flame retardants should be given high priority.

- Investigation of possible legislation against the use of urethane foams in upholstery and bedding, based on the proposed toxicity of smoke and fumes generated by burning urethane foams. Actually, the entire question of fire resistance, smoke generation, and fumes toxicity needs careful reevaluation. Previously developed standards were oriented primarily toward burn rate and support of combustion with little or no concern for smoke generation and toxicity of combustion by-products. Recently, it has been suggested that more deaths occur from smoke and gas inhalation than from the heat of combustion.
- Investigation of the feasibility of developing new equipment and processes for automatic cleaning, separating, and handling mill waste to reduce the overall labor needs and to improve working conditions for workers. Consideration might be given to recommending certain tax incentives or subsidies of the development or installation of waste processing equipment.

General Research Requirements

Most of the recommended actions described in the previous sections were directed toward three specific problem areas of fiber blends, wool, and cotton mill waste. Additional actions also probably are needed to help maintain the secondary textile industry in its very vital position in waste recycling. Therefore, more general research might include:

- A detailed investigation of the space and capital equipment needs of the secondary materials dealer. This, of course, closely parallels the comments made previously in discussing the needs of the cotton mill waste dealer. However, a comprehensive study of available equipment, investment requirements, preferred operating procedures, and plant location studies might help some of the more marginal secondary dealers to continue to operate. Municipal support of selected dealerships might be justified where it can be shown that the secondary materials industry provides for the removal of large quantities of material that are potentially a solid waste burden.
- A specific study to determine how general reductions in the contribution of labor to cost can be made. These reductions might be realized through the development of automatic sorting equipment or improved equipment to supplement labor. As mentioned previously, tax incentives or governmental funds might be provided for the development of this equipment or its installation.
- Investigation of the feasibility and means to reduce transportation costs in order to facilitate textile waste reuse domestically and overseas.

- An investigation of the impact of local, state, and federal pollution legislation on textile waste recycling should be undertaken. Consideration would be given to the factors that act as both stimulants and deterrents to textile waste utilization.
- An investigation of the impact of the development and growth of disposable nonwoven fabrics on textile waste utilization should be initiated. If this study indicates that waste textile fibers can be used extensively in disposable nonwoven structures, then additional research might be directed toward developing products to utilize specific waste textile fibers. Consideration should be given to the fact that disposable nonwoven products may present more of a waste recovery problem than the original waste textile fiber. Furthermore, disposable nonwoven wipers may have adverse effects on the secondary materials dealer who depends on the old rag wiper business to maintain his marginal business.

APPENDIX A

INFORMATION ON VARIOUS SOURCES AND
CATEGORIES OF SECONDARY TEXTILE FIBERS

AMERICAN TEXTILE MANUFACTURERS INSTITUTE, INC.

301 JOHNSTON BUILDING
CHARLOTTE, N. C. 29202

November 20, 1970

TO PRODUCERS OF COTTON MILL WASTE FOR SALE

Gentlemen:

Enclosed is ATMI's consolidated report on "Shipments of Cotton Mill Waste for Sale" covering the Third Quarter, 1970.

Based on 125 individual mill returns, shipments of cotton waste totaled 44,033,986 pounds with a value of \$2,376,097 during the 13-week period ended October 3, 1970. The computed average value of these shipments at 5.40 cents per pound compares with an average of 5.27 cents per pound in the previous Second Quarter of 1970, and an average of 5.44 cents per pound during the Third Quarter, a year ago.

SHIPMENTS OF WHITE COTTON MILL WASTE FOR SALE
(average cents per pound)

Classification	13 wks. ended <u>10/3/70</u>	13 wks. ended <u>7/4/70</u>	13 wks. ended <u>9/27/69</u>
Jute Bagging.....	4.58	4.58	5.15
Motes.....	1.61	1.87	2.75
Dusthouse.....	0.72	0.76	1.54
Card Fly.....	2.15	2.25	2.91
Card Strips.....	7.06	7.08	6.80
Comber Noils.....	13.56	12.95	11.50
Clearer.....	2.02	2.02	2.76
Card/Spinning Room Sweeps...	0.60	0.74	1.13
Soft-Threads (white).....	5.45	5.44	4.81
Hard/Slasher Threads (white)	1.38	1.65	1.97
Clean Rags.....	<u>4.77</u>	<u>7.48</u>	<u>6.26</u>
Total Cotton Waste.....	<u>5.40</u>	<u>5.27</u>	<u>5.44</u>

A more detailed tabulation of Third Quarter 1970 data is attached for your further information.

Statistics Section, Economic Information Division
American Textile Manufacturers Institute, Inc.

Attachment

AMERICAN TEXTILE MANUFACTURERS INSTITUTE, INC.

1501 JOHNSTON BUILDING
CHARLOTTE, N. C. 28202

May 26, 1966

TO PRODUCERS OF WHITE COTTON MILL WASTE FOR SALE

Gentlemen:

Enclosed is ATMI's consolidated report on "Shipments of White Cotton Mill Waste for Sale" covering the First Quarter, 1966.

Based on 129 individual mill returns, shipments of cotton waste totaled 56,267,823 pounds, with a value of \$4,615,452 during the 13-week period ended April 2, 1966. The computed average value of these shipments at 8.20 cents per pound compares with an average 8.03 cents per pound in the previous Fourth Quarter of 1965, and an average of 8.98 cents per pound during the First Quarter, a year ago.

SHIPMENTS OF WHITE COTTON MILL WASTE FOR SALE
(average cents per pound)

Classification	13 wks. ended 4/2/66	13 wks. ended 1/1/66	13 wks. ended 4/3/65
Jute Bagging.....	7.04	7.25	7.63
Motes.....	3.31	3.23	4.25
Dusthouse.....	1.32	1.22	2.61
Card Fly.....	3.43	3.46	4.64
Card Strips.....	12.22	12.60	13.21
Comber Noils.....	14.19	12.90	15.44
Clearer.....	3.77	3.88	4.44
Card Room Sweeps.....	1.07	0.98	2.05
Spinning Room Sweeps.....	0.92	0.86	1.92
Soft Threads (not garnetted).....	8.73	8.46	9.18
Hard Threads & Slasher Threads...	4.87	4.63	5.86
Clean Rags.....	10.15	7.31	7.15
Total.....	8.20	8.03	8.98

A more detailed tabulation of First Quarter 1966 data is attached for your further information.

Statistics Section, Economic Information Division
American Textile Manufacturers Institute, Inc.

Attachment

National Association of Secondary Material Industries, Inc.

Standards and Practices for Wool Stock

CIRCULAR WS-63

(Approved by Textile Division,
N. A. S. M. I.)



Official Copies of this Classification always carry the Association's Seal

EFFECTIVE AS OF APRIL 1, 1963
(Supersedes GWS-53)

Issued from
ASSOCIATION HEADQUARTERS
271 Madison Avenue, New York 16, N. Y.

COMBINED STANDARDS AND PRACTICE

1. **QUANTITY**—If the terms "more or less" or "about" or similar terms are used, it is understood that delivery may be for a variance of 10% on the specified commodity.

A. A contract for a carload unless otherwise agreed upon, shall mean the minimum quantity recognized by the official classification tariff of the district in which the seller is located.

B. A short ton shall be understood to be 2,000 lbs. A metric ton shall be understood to be 2204.6 lbs. A long ton shall be understood to be 2240 lbs.

2. **PROMPT** shipping instruction means shipment within fourteen days of order date unless otherwise agreed upon between buyer and seller. **IMMEDIATE** shipping instruction means shipment within five days of order date unless otherwise agreed upon between buyer and seller.

3. All deliveries shall be as represented by the seller. Any delivery containing in excess of the specified amount of rejections may, at the buyer's option, be rejected or with seller's approval assorted and the objectionable excess material may be taken to account at market price or returned.

4. New sweater cutters, seamers, jerseys, thread waste, and all other new woolen stock shall be sold on a net weight basis. All old woolen stock and new woolen clips shall be sold on a 5% maximum tare basis. The bales to be packed in tare consisting of wrappings which will not contaminate the contents.

5. All merchandise to be weighed over tested scales and detailed weight notes to be furnished with invoices.

6. **MOISTURE** in excess of the natural content is not allowable. If excess moisture content is found, it gives the buyer the right to rejection or price adjustment with the approval of the seller.

7. All contracts are subject to civil commotion, strikes, fires, floods and other acts of God, with the buyer having the option of cancelling the portion of the contract so delayed without penalty to the seller or he may elect to take the goods at contract price; if he so elects, shipment to be effected at a time mutually agreed between buyer and seller. In case of loss of all or any portion of the goods covered by a contract made under this agreement, the quantity lost shall not be replaced.

A. In the event of a general embargo of railroad transportation companies, because of which shipment cannot be made within the time specified on the order, the order shall remain in force provided the embargo does not continue for more than two weeks, and shipment is made within reasonable time after the embargo is lifted.

B. The seller shall immediately notify the buyer when he is unable to ship because of a general freight embargo and the buyer shall within 48 hours after receiving such notification, week-ends and holidays excluded, advise the seller either by mail or telegraph, whether he elects to have the order remain in force or cancelled in case embargo remains in force longer than two weeks.

C. In the event an embargo is in force for a period of two weeks the buyer has the right within that period to designate another means of transportation. Should the change in transportation result in increased shipping cost, the difference in price shall be borne by the buyer.

8. Terms shall be as agreed between buyer and seller.

9. A contract should include the following:

A. **MATERIAL**: Material specified as subject to classification or specification adopted by the National Association of Secondary Material Industries, Inc.

B. **QUANTITY**: Should be definite.

C. **PRICE**: Should be stated in definite figures per specific unit of weight.

D. **PLACE OF PURCHASE**: Should be specifically stated if F.A.S. or delivered pier. Wharfage and unloading for the account of the seller.

E. **SHIPMENT**: Whenever possible, shipping instructions should be part of the contract.

F. **DELIVERY**: Should be stated.

G. **TERMS**: Must be inserted as agreed upon.

H. **CONDITIONS**: Any conditions affecting the contract shall be set forth in clear and definite terms.

I. **RESPONSIBILITY AND ARBITRATION**. It is recommended that the following two clauses regarding responsibility and arbitration be included as a part of all contracts.

CONTRACTS: RESPONSIBILITY

The retention of stock without written claim or objection for more than 30 days or after the picking, mixing or carding or other processing of the stock in any manner, whichever shall come first, shall constitute an unconditional acceptance of the same by the buyer; and thereafter no such stock shall be returned nor any claim or liability whatsoever relating to such a stock survive against the seller, except where excess tare or improper packing are found upon use of stock.

CONTROVERSIES: ARBITRATION

The parties hereto agree that if, within ten days after written notice thereof, they are unable through informal mediation or otherwise to settle any controversy or claim arising out of or relating to this contract or the breach thereof, then the same shall be settled by arbitration in accordance with the Rules of the American Arbitration Association and the judgment upon the award rendered by the arbitrator(s) may be entered in any court having jurisdiction thereof.

10. The following are the grade definitions established by the Textile Division for old wool stock:

WOOL STOCK Circular WS-63 — EFFECTIVE AS OF APRIL 1, 1963

GRADED WOOL STOCK

All deliveries must be as represented by the seller and may contain rejections not exceeding 5% based on net weight of accepted material, to be paid for at purchase price. Any delivery containing in excess of the specified amount of rejections may, at the buyer's option, be rejected and with seller's approval assorted and the objectionable excess material may be taken to account at the market price or returned. All the outthrows produced in resorting may either be returned for full credit to the seller or may be paid for at a price agreed upon by buyer and seller. Objectionable materials shall include all cotton, rayon, unskirted material and synthetics.

MIXED ROUGH WORSTEDS

To contain all grades and colors of men's worsted pants, suit jackets, and men's worsted topcoats. This stock may contain rejections not exceeding 5% based on net weight of accepted material, to be paid for at purchase price. Any delivery containing in excess of the specified amount of rejections may, at buyer's option, be rejected and with seller's approval assorted and the objectionable excess material may be taken to account at market price or returned.

ROUGH WOOL BODIES

To contain all colors and grades of ladies' wool coats. This stock may contain rejections not exceeding 5% based on net weight of accepted material, to be paid for at purchase price. Any delivery containing in excess of the specified amount of rejections may, at buyer's option, be rejected and with seller's approval assorted and the objectionable excess material may be taken to account at market price or returned.

ROUGH MIXED KHAKI

To contain a minimum of 60% of rough khaki wool worsted jackets and pants and 40% of khaki wool overcoatings and/or suitings. This stock may contain rejections not exceeding 5% based on net weight of accepted material, to be paid for at purchase price. Any delivery containing in excess of the specified amount of rejections may, at the buyer's option, be rejected and with seller's approval assorted and the objectionable excess material may be taken to account at market price or returned.

ROUGH KHAKI WORSTEDS

To contain khaki wool worsted jackets and pants. This stock may contain rejections not exceeding 5% based on net weight of accepted material, to be paid for at purchase price. Any delivery containing in excess of the specified amount of rejections may, at the buyer's option, be rejected and with seller's approval assorted and the objectionable excess material may be taken to account at market price or returned.

ROUGH KHAKI CLOTH

To contain khaki wool overcoatings, jackets and pants. This stock may contain rejections not exceeding 5% based on net weight of accepted material to be paid for at purchase price. Any

delivery containing in excess of the specified amount of rejections may, at the buyers' option, be rejected and with seller's approval assorted and the objectionable excess material may be taken to account at market price or returned.

MIXED ROUGH OVERCOATING

To consist of all colors and grades of mens wool overcoatings, pea jackets, mackinaws, snow suits and snowsuit pants. This stock may contain rejections not exceeding 5% based on net weight of accepted material, to be paid for at purchase price. Any delivery containing in excess of the specified amount of rejections may, at the buyer's option, be rejected and with seller's approval assorted and the objectionable excess material may be taken to account at market price or returned.

MIXED ROUGH SUITINGS

To contain all colors of men's wool jackets, topcoats and pants, either tweeds or flannels. This stock may contain rejections not exceeding 5% based on net weight of accepted materials, to be paid for at purchase price. Any delivery containing in excess of the specified amount of rejections may, at the buyer's option, be rejected and with seller's approval assorted and the objectionable excess material may be taken to account at market price or returned.

MIXED WOOL KNITS

To contain all grades and colors of wool knitwear. This stock may contain rejections not exceeding 5% based on net weight of accepted material, to be paid for at purchase price. Any delivery containing in excess of the specified amount of rejections may, at the buyer's option be rejected and with the seller's approval assorted and the objectionable excess material may be taken to account at market price or returned.

SKIRTED MIXED WOOL MERINOES

To contain all grades and colors of wool garments that are free of linings. This stock may contain rejections not exceeding 5% based on net weight of accepted material, to be paid for at purchase price. Any delivery containing in excess of the specified amount of rejections may, at the buyer's option be rejected and with the seller's approval assorted and the objectionable excess material may be taken to account at market price or returned.

11. The following are the grade definitions as have been established by the Textile Division for new woolen stock:

MIXED WORSTED

To contain new woven cuttings, free of sewings, made from worsted yarns and free of synthetics.

MIXED TWEED

To contain new unfelted woven cuttings, free of sewings, made from coarse woolen yarns of two or more colors and free of synthetics.

MIXED SHETLAND

To contain new unfelted woven cuttings, free of sewings, made from woolen yarns and cuttings to be all in solid colors and free of synthetics.

MIXED FLANNEL

To contain new unfelted woven cuttings, free of sewings, made from fine woolen yarns and cuttings to be all in solid colors and free of synthetics.

MIXED OVERCOATING

To contain new woven cuttings, free of sewings, made from woolen yarns and free of synthetics.

MIXED GABARDINES

To contain new woven cuttings, free of sewings, made from worsted yarns and cuttings, solid in color and free of synthetics.

MIXED WORSTED SWEATER CUTTERS

To contain new knitted, unfelted cuttings, free of sewings, made from worsted yarns and free of synthetics.

MIXED WORSTED SEAMERS

To contain sewed cutoffs of sweater cuttings, free of synthetics.

MIXED WORSTED JERSEY

To contain new fine unfelted, knitted cuttings, free of sewings, made from single-ply worsted yarn and free of synthetics.

MIXED WOOLEN SWEATER CUTTERS

To contain new knitted, unfelted cuttings, free of sewings, made of woolen yarns and free of synthetics.

WORSTED THREAD WASTE

To contain all-wool spinning and/or weaving threads consisting of worsted-spun yarns and free of synthetics.

WOOLEN THREAD WASTE

To contain all-wool spinning and/or weaving threads consisting of wool-spun yarns and free of synthetics.

National Association of Secondary Material Industries, Inc.

Standards and Practices for Cotton-Synthetics

CIRCULAR CS-65

(Approved by Textile Division,
N. A. S. M. I.)



Official Copies of this Classification always carry the Association's Seal

EFFECTIVE AS OF JANUARY 1, 1965
(Supersedes CR-50)

Issued from
ASSOCIATION HEADQUARTERS
271 Madison Avenue, New York, N. Y. 10016

P R E A M B L E

These standards and practices are recommended for use in the United States and Canada. Contracts and specifications for export transactions should be negotiated on an individual basis.

Basic to the success of any buyer-seller relationship is an atmosphere of "good faith." In keeping with this, the following underlying principles have been accepted as necessary to the maintenance of amicable dealings:

1. Sellers must use due diligence to ascertain that shipments consist of properly packed stock and that shipment is made during the period specified.
2. Arbitrary rejections, deductions and cancellations by the buyer are counter to acceptable good trade practice.
3. Shippers must guarantee the quality of all stock shipped but shall not warrant its use or the finished product made therefrom.

Each transaction covering the purchase or sale of materials described in this circular should be confirmed in writing and include agreement on the following items:

1. **QUANTITY:** If the terms "more or less" or "about" or similar terms are used, it is understood that delivery may be for a variance of 10% on the specified commodity.
 - A. A contract for a carload unless otherwise agreed upon, shall mean the minimum quantity recognized by the official classification tariff of the district in which the seller is located.
 - B. A short ton shall be understood to be 2,000 lbs.
A metric ton shall be understood to be 2204.6 lbs.
A long ton shall be understood to be 2240 lbs.
2. **PROMPT** shipping instructions means shipment within fourteen days of order date unless otherwise agreed upon between buyer and seller. **IMMEDIATE** shipping instructions means shipment within five days of order date unless otherwise agreed upon between buyer and seller.
3. All deliveries shall be as represented by the seller. Any delivery containing in excess of the specified amount of rejections may, at the buyer's option, be rejected or with seller's approval assorted and the objectionable excess material may be taken to account at market price or returned.

4. All merchandise to be weighed over tested scales and detailed weight notes to be furnished with invoices.
5. **MOISTURE** in excess of the natural content is not allowable. If excess moisture content is found, it gives the buyer the right to rejection or price adjustment with the approval of the seller.
6. Terms shall be as agreed between buyer and seller.
7. Tare weight not to exceed 3%.

NEW CUTTINGS

All grades as defined herein must be clean, dry and free of rubber, leather, slasher, wool, silk, rayon, wood, paper, muss, pasted stock, adhesives, masking tape, plastics, paint, acetate, grease, oil, paraffin, latex, water-proofed materials or synthetic materials and any other foreign materials, unless otherwise specified.

The specifications for some of the grades listed below indicate specific exclusion of synthetic fibers and other injurious materials to the papermaking process. They are mentioned in the particular specifications for emphasis and because the particular grades are more susceptible to such foreign material. However, the limitations in the foregoing paragraph are applicable, not only to the grades for which the specific limitations are mentioned, but also to all of the grades when referred to in sales for use in writing paper mills.

Specifications For Grades

1. **No. 1 WHITE SHIRT CUTTINGS AND/OR BLEACHED WHITE DUCK CUTTINGS:** Table cuttings of white shirts, b.v.d.'s, bleached twill, drill or duck materials, accumulated from shirt factories or other garment factories, free of color, starched or loaded materials, and lawns.
2. **No. 1 WHITE HEADINGS AND/OR BLEACHED WHITE DUCK HEADINGS:** Headings of white shirts, b.v.d.'s, or sheeting material, bleached twill, drill or duck materials, free of color, starched or loaded materials, lawns and thrums.
3. **WHITE TERRY COTTON,** free of synthetics, colors, and colored thread.
4. **WHITE LAWN CUTTINGS AND/OR HEADINGS:** Table cuttings of white materials of lighter weight than No. 1 White Shirt Cuttings and/or Headings, including embroidered materials, which must be free of starched or loaded materials and laces.

5. **WHITE SHRUNK CUTTINGS AND/OR HEADINGS:** White cuttings and/or headings which may be loaded or starched, but free of wigin or buckram.
6. **No. 1 UNBLEACHED MUSLIN CUTTINGS:** Table cuttings of unbleached materials of sheeting, drill, twill or muslin construction; the packing must be free of unbleachable colored selvages, starched or loaded cuttings, canton flannel glove cuttings, heavily shived materials, heavy canvas, osnaburgs and thrums.
7. **No. 1 UNBLEACHED HEADINGS:** Headings of unbleached materials of sheeting, drill, twill or muslin construction; the packing must be free of unbleachable colored selvages, starched or loaded cuttings, canton flannel glove cuttings, heavily shived materials, heavy canvas, osnaburgs and thrums.
8. **No. 1 UNBLEACHED THRUMS:** New unbleached strips, mill stock with threads attached and may contain mill and weaver knots but must be free of slasher and unbleachable colored selvages.
9. **HEAVY UNBLEACHED CANVAS CUTTINGS:** Heavy unbleached canvas cuttings, with or without colored stripes.
10. **OSNABURG CUTTINGS:** The same materials defined in No. 1 Unbleached Cuttings, except that they may contain shivy cuttings.
11. **BLEACHED FLANNEL CUTTINGS AND/OR HEADINGS:** Table cuttings of bleached canton flannel or flannelette linings and/or headings.
12. **UNBLEACHED FLANNEL CUTTINGS:** Table cuttings of unbleached flannel or flannelette linings and/or headings.
13. **BLEACHED AND/OR UNBLEACHED WIGGIN CUTTINGS:** Cuttings of starched, openweave buckram materials.
14. **No. 1 BLEACHED SHOE CUTTINGS:** Table cuttings of bleached materials from shoe linings. This material may be starched or drilled or fleece-backed, but free of pasted stock.
15. **No. 1 UNBLEACHED SHOE CUTTINGS:** Table cuttings of unbleached materials from shoe linings. This material may be starched or drilled or fleece-backed, but free of pasted stock.
16. **HEAVY DRILL UNBLEACHED SHOE CUTTINGS:** Table cuttings of unbleached materials from shoe linings which may be starched, but which must be free of fleece-backed shoe cuttings, and pasted stock.
17. **UNBLEACHED FLEECE-BACKED SHOE CUTTINGS:** Table cuttings of unbleached fleece-backed materials from shoe linings which may be starched; the packing may contain heavy drill unbleached shoe cuttings, but must be free of pasted stock.
18. **EASTERN CANTON FLANNEL GLOVE CUTTINGS:** Table cuttings of unbleached material accumulated by cotton or canvas glove factories, and which must be free of colored stock.
19. **STRIPED GLOVE CUTTINGS:** Glove cuttings of various colored stripes.
20. **BLEACHABLE YELLOW AND/OR BLUE STRIPED GLOVE CUTTINGS:** Table cuttings of bleachable yellow and/or blue striped glove materials, free of all other colors.
21. **TAN AND/OR GREY GLOVE CUTTINGS:** Table cuttings of tan and/or grey glove materials, free of all other colors.
22. **MIXED GLOVE CUTTINGS:** Table cuttings of mixed colored gloves.
23. **WINE BROWN JERSEY GLOVE CUTTINGS:** Table cuttings of wine brown jersey gloves, free of all other colors.
24. **PASTEL MUSLIN CUTTINGS:** Bleachable pink and/or peach and/or blue and/or pastel woven table cuttings or crinkly pajama cuttings which must be free of rubber and corset cuttings.
25. **No. 1 LIGHT SILESIA:** Table cuttings of linings from men's clothing, free of black threads, heavily starched or loaded materials and dark colors.
26. **No. 1 NEW GREY SILESIA:** Table cuttings of linings from men's clothing consisting exclusively of bleachable grey colors.
27. **No. 1 NEW CREAM SILESIA:** Table cuttings of linings from men's clothing consisting exclusively of bleachable cream colors.
28. **No. 1 LIGHT FLANNELETES:** Pastel and light printed flannelette table cuttings.
29. **GREY FLANNELETTE CUTTINGS:** Interlinings of coats which may include tan Kasha.
30. **TAN KASHA:** Only tan interlinings of coats.
31. **No. 1 PERCALES:** Table cuttings of light colored print rags from shirts, shorts and pajamas; the packing may contain bleachable solid colors but must be free of woven materials and dark colors.

32. **No. 1 LIGHT PRINTS:** Printed table cuttings of ladies' garments; the packing may contain bleachable solid colors but must be free of woven materials.
33. **BLEACHABLE DENIMS:** Table cuttings of white-backed blue overall materials or blue overall materials with express-stripes. The packing must be free of colored threads and thrums. They must be bleachable.
34. **BLUE DENIM THRUMS:** New white-backed blue overall, express-striped blue overall or bleachable blue overall strips, mill rags with threads attached. The packing may contain mill and weaver knots but must be free of slasher.
35. **UNBLEACHABLE DENIMS:** Table cuttings of blue overall materials that are not bleachable.
36. **MIXED SPORT DENIMS:** Table cuttings of all denim materials and weights, free of synthetics.
37. **INDIGO BLUE CUTTINGS:** Table cuttings of indigo blue materials.
38. **BLACK AND WHITE COVERTS:** Table cuttings of black and white cotton covert materials.
39. **GREY COVERTS:** Table cuttings of grey cotton covert materials.
40. **BLUE COVERTS:** Table cuttings of blue cotton covert materials.
41. **GREY CHEVIOTS:** Table cuttings of grey cheviot shirt materials.
42. **BLUE CHEVIOTS:** Table cuttings of blue cheviot shirt materials.
43. **BLUE CHAMBRAY CUTTINGS:** Table cuttings of blue chambray materials.
44. **TICKING CUTTINGS (MATTRESS CUTTINGS):** Table cuttings of light colored mattress cuttings which must be free of feathers, hair, metallic substances, dark colored materials and treated materials.
45. **FANCY SHIRT CUTTINGS:** Table cuttings of woven and printed cotton materials accumulated from shirt factories.
46. **No. 1 WASHABLES:** Colored cuttings in print or solid colors. Woven materials may be included.
47. **SUN TAN KHAKI CUTTINGS:** Table cuttings from pants and shirting materials of sun tan shades.
48. **GREY CHINO CUTTINGS:** Table cuttings from pants and shirting materials of grey twill and drill.
49. **HERRINGBONE GREEN TWILL CUTTINGS:** Table cuttings of herringbone green twill materials.
50. **MIXED KHAKI CUTTINGS:** Table cuttings of any and all shades of khaki cuttings.
51. **CORDUROY CUTTINGS:** Table cuttings from corduroy garments free of cottonades and unions.
52. **COTTONADES:** Table cuttings of all work garments or similar materials of all colors, free of unions.
53. **NEW ROOFING CUTTINGS:** Consisting of a mixture of cuttings, any and all colors from garments of rayon, silk, synthetic fibers, cotton, wool, or a mixture of any or all of the above mentioned fibers. Not guaranteed free of rubber.
54. **COLORED SYNTHETIC CUTTINGS:** Consisting of a mixture of cuttings, any and all colors, from garments of rayon, silk, cotton or synthetic fibers but must be free of wool, haircloth and metallic fibers.
55. **BLEACHED UNDERWEAR CUTTERS (FREE OF FLEECE-LINED CUTTERS):** Table cuttings of bleached underwear, free of trimmings, noodles, seamers, and synthetic materials.
56. **BLEACHED UNDERWEAR CUTTERS (WITH FLEECE-LINED CUTTERS):** Table cuttings of bleached underwear, free of trimmings, noodles, seamers and synthetic materials.
57. **UNBLEACHED OR EGYPTIAN UNDERWEAR CUTTERS (FREE OF FLEECE-LINED CUTTERS):** Table cuttings of unbleached underwear, free of trimmings, noodles, seamers and synthetic materials.
58. **UNBLEACHED OR EGYPTIAN UNDERWEAR CUTTERS (WITH FLEECE-LINED CUTTERS):** Table cuttings of unbleached underwear, free of trimmings, noodles, seamers and synthetic materials.
59. **BLEACHABLE PASTEL UNDERWEAR CUTTERS:** Table cuttings of bleachable pastel shades of underwear, free of trimmings, noodles, loopers, seamers and synthetic materials.
60. **PASTEL COLORED TERRY COTTON:** Free of synthetics, consisting of only pastel colors.
61. **SILVER GREY OR RANDOM UNDERWEAR CUTTERS (FREE OF FLEECE-LINED CUTTERS):** Table cuttings of bleachable silver grey or random underwear cutters, free of trimmings, noodles, loopers, seamers and synthetic materials.

62. **MIXED SILVER GREY AND/OR RANDOM CUTTERS:** Table cuttings of bleachable silver grey or random underwear cutters, free of noodles, loopers, and seamers, containing fleeced and unfleeced materials.
63. **DARK COLORED KNITTED UNDERWEAR CUTTERS:** Table cuttings of solid colored underwear or knitted materials, which must be free of seamers.
64. **JAZZ CUTTERS:** Table cuttings of striped and/or solid colored underwear or knitted materials, which must be free of seamers.
65. **CREAM SILK OR RAYON STRIPED UNDERWEAR CUTTERS:** Table cuttings of cream colored underwear cutters which may contain silk or rayon stripes, free of trimmings, noodles, loopers and seamers.
66. **BLEACHED UNDERWEAR SEAMERS (FREE OF FLEECE-LINED):** Bleached trimmings from underwear, may contain facings.
67. **BLEACHED UNDERWEAR SEAMERS:** Bleached trimmings from underwear.
68. **MIXED BLEACHED AND UNBLEACHED UNDERWEAR SEAMERS:** White and unbleached trimmings from underwear.
69. **CREAM SILK OR RAYON STRIPED SEAMERS:** Cream colored trimmings from underwear which may contain silk stripes or rayon stripes and facings.
70. **PASTEL UNDERWEAR SEAMERS:** Pastel trimmings from underwear.
71. **DARK COLORED UNDERWEAR SEAMERS:** Colored trimmings from underwear.
72. **UNBLEACHED LOOPERS AND PIECES:** Unbleached hosiery loopers and pieces.
73. **WHITE OR CREAM LINEN CUTTINGS:** Table cuttings of white or cream materials, woven from flax, free of colored selvages.
74. **GREY OR UNBLEACHED LINEN CUTTINGS:** Table cuttings of grey or unbleached materials, woven from flax, free of red selvages.
75. **WHITE OR CREAM LINEN CUTTINGS WITH COLORED SELVAGES:** Table cuttings of white or cream colored materials, woven from flax, with colored selvages.
76. **GREY OR UNBLEACHED LINEN CUTTINGS WITH COLORED SELVAGES:** Table cuttings of grey or unbleached materials, woven from flax, with colored selvages.
77. **COLORED LOOPERS AND PIECES:** Colored hosiery loopers and pieces.
78. **AMERICAN LINEN:** Bleachable padding from men's clothing which may contain linen.
79. **OLIVE GREEN COTTON SATEEN:** Free of treated and/or synthetic materials.

OLD RAGS

Specifications For Grades

80. **No. 1 WHITES (REPACKED):** Clean white cotton rags, free of curtains, canvas and colored rags, must not contain mussy or stringy rags or wiper trimmings.
81. **MIXED WHITES (REPACKED):** Clean and soiled white cotton rags, commercially free of any dump rags, street rags, scorched rags, must not contain wiper trimmings.
82. **No. 1 WHITE LAUNDRY BAGS:** Clean, dry, white cotton laundry bags, commercially free of unbleachable color and stripes.
83. **MIXED LAUNDRY BAGS:** Clean and soiled, white or off-colored, dry cotton laundry bags.
84. **WHITE WIPER TRIMMINGS:** Shall consist of white cotton trimmings, commercially free of synthetics, can contain rags with buttons and metal.
85. **COLORED WIPER TRIMMINGS:** Shall consist of colored cotton trimmings, commercially free of synthetics, can contain rags with buttons and metal.
86. **BLUES AND MIXED WHITES (REPACKED):** Consists of Mixed Whites (repacked) and Blues (repacked). Rags strictly of house collection, commercially free of solid blacks and reds. Shall not contain old corsets, socks, stockings or new cuttings, must be free of rubberized materials and plastics.
87. **BLUES (REPACKED):** Rags strictly of house collection, commercially free of solid blacks and reds. Shall not contain old corsets, socks, stockings or new cuttings, must be free of rubberized materials and plastics.

88. **OLD COTTON PANTS:** Shall consist of all complete cotton garments, commercially free of oil, rubber, leather, grease, paint and miner's garments. Must not contain strips, skeleton garments or synthetics.
89. **MIXED COTTON PANTS AND OVERALLS:** Shall consist of all complete cotton garments, commercially free of oil, rubber, leather, grease, paint and miner's garments. Must not contain strips, skeleton garments or synthetics.
90. **OLD BLUE OVERALLS:** Shall contain only blue overalls consisting of complete cotton garments, commercially free of oil, rubber, leather, grease, paint and miner's garments. Must not contain strips, skeleton garments or synthetics.
91. **COTTON FILLED QUILTS:** Quilts consisting of cotton only, commercially free of wool, synthetics, metallics, rubber and plastics.
92. **COTTON PANTS TOPS:** Shall consist of square cut cotton pants tops without legs, commercially free of oil, rubber, leather, grease, paint and miner's garments. Must not contain strips, skeleton garments or synthetics.
93. **BLUE OVERALL TOPS:** Shall contain only square cut blue cotton overall tops, commercially free of oil, rubber, leather, grease, paint and miner's garments. Must not contain strips, skeleton garments or synthetics.

SUPPLEMENTAL CLASSIFICATION AS OF MAY 1, 1967

94. **MIXED INSTITUTION RAGS** shall consist of all items of clothing and household textiles, except those items removed for sale as clothing in the retail store of the institution. Mixed Institution Rags shall not contain American flags, carpets, rugs, stuffed toys, cotton pillows, mattresses, rubberized materials, plastic materials, cattle hair pads, belts, fiberglass items, or any items of any nature not considered in the textile category. No other items shall be removed from "honest" mixed institution rags that will cause the mixed rags to be reduced in value.

APPENDIX B

SUMMARY OF BASIC STATISTICAL DATA
RELATED TO THE GENERATION AND
USE OF SECONDARY TEXTILE FIBER

APPENDIX B

SUMMARY OF BASIC STATISTICAL DATA
RELATED TO THE GENERATION AND
USE OF SECONDARY TEXTILE FIBER

I. Extensive Survey Results

(Volume of Cutting and Rags Handled)

Cotton	415.0 X 10 ⁶ lbs
Wool	162.5 X 10 ⁶ lbs
Synthetic	167.5 X 10 ⁶ lbs
Synthetic blends	265.0 X 10 ⁶ lbs
Total	1,010.0 X 10 ⁶ lbs

II. Cotton Mill Waste

(Based on Third Quarter 1970 report from American Textile
Manufacturers Institute, Inc., Charlotte, North Carolina)

"Based on 125 individual mill returns, shipment of cotton waste totaled 44,033,986 pounds.....". These data were multiplied by 4.0 and rounded to give a total of 200 million pounds/year.

III. Synthetic Fiber Producers Waste

(Based on Textile Organon, Vol XLI, 1970, page 31)

Synthetic fiber shipments for 1969 included 39.4 million pounds of rayon and 162.7 million pounds of noncellulosic, indicating a minimum of 200 million pounds.

IV. U.S. Tariff Commission Data on Consumption of Rags

(Summaries of Trade and Tariff Information, Schedule 3, Volume 6, 1968, pages 119-124)

Based on use of old and new rags by the following industries
(millions of pounds)

Paper and paperboard	425	
Roofing and Linoleum	200	
Fibrous form (reprocessing, flock)	250	
Wiping rags	300	(\$60 million)
Wool	100	
Exports (1967)	342	
Total	1617	

V. National Association of Secondary Materials

(Paper presented at Textile Workshop, Recycling Day, Feb. 2, 1971,
by R. H. Frankel, Vice President of NASMI)

Waste Generation

New cuttings and clippings	300-400 million lbs/year
Old Clothing	120 million lbs/year

Users

Paper Industry	62 million lbs (1967)
	44 ditto (1970)
Vulcanized Fiber	100 million lbs (1969)
	60 ditto (1970)

VI. Battelle Estimate of Old and New Rags Available in 1970

A. Estimate of Old Rags Available 1970

Apparel: Assume life cycle of 5 years for apparel; 1965 consumption of fibers was 3.6 billion pounds. Assume 1.6 billion is unrecoverable consumption--wear and loss in washing, etc.--leaving 2 billion pounds to be recycled or disposed.

Home Furnishings: Assume life cycle of 10 years; 1960 consumption of fibers was 1.30. Assume 0.3 billion is unrecoverable consumption due to wear, fire, etc.--leaving 1 billion pounds to be disposed.

Total: Assume old rags from industrial and miscellaneous products to be negligible, the total old rags available for recycling in 1970 was about 3 billion pounds. Of this, about 30 percent or 750 million pounds enters the dealers' processing operation and 2.2 billion would be discarded.

B. Estimate of New Rags Available from Apparel Trimmings (1970)

(Survey of 5 percent of apparel industry based on yards converted)

Assume 4.1 billion pounds of fiber consumed in apparel manufacture in 1970. Survey indicates trimmings of 10 percent with 60 percent of the waste being salvaged and sold to dealers. The other 40 percent is dumped.

Therefore, 400 million pounds of waste are generated with 240 million pounds going to dealers and 160 million pounds to the dump. If a similar estimate using 5 percent waste generation is used for home furnishings at 3.0 billion pounds for 1970, then 90 million pounds of scrap would go to dealers in the form of remnants and trim waste. Approximately 60 million pounds would be dumped.

This indicates an estimated 330 million pounds of new rags generated in manufacture of apparel and home furnishings are sent to dealers each year.

Total rags available in 1970 includes 750 million pounds of old rags and 330 million pounds of new rags, or a total of about 1.1 billion pounds of rags.

Total rags being dumped or burned include 2.2 billion pounds of old rags and 220 million pounds of new rags. In addition, some rags entering the dealer's plant are eventually removed and destroyed for a total of about 2.5 billion pounds.

APPENDIX C

COMMON MAN-MADE FIBERS

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APPENDIX C

COMMON MAN-MADE FIBERS

Data presented in this Appendix were taken directly from the publication, Guide to Man-Made Fibers, published by the Man-Made Fibers Association, Inc., 350 Fifth Avenue, New York, New York 10001.

Extract from Federal Trade Commission Rules and Regulations under the Textile Fiber Products Identification Act

Pursuant to the provisions of Section 7(c) of the Act, the following generic names for manufactured fibers, together with their respective definitions, are hereby established:

- (a) **acrylic** — a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of acrylonitrile units ($-\text{CH}_2-\text{CH}-$).



- (b) **modacrylic** — a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of less than 85% but at least 35% by weight of acrylonitrile units ($-\text{CH}_2-\text{CH}-$), except fibers qualifying under



category (2) of Paragraph (j) of Rule 7.

- (c) **polyester** — a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of an ester of a dihydric alcohol and terephthalic acid ($\text{p}-\text{HOOC}-\text{C}_6\text{H}_4-\text{COOH}$).

- (d) **rayon** — a manufactured fiber composed of regenerated cellulose, as well as manufactured fibers composed of regenerated cellulose in which substituents have replaced not more than 15% of the hydrogens of the hydroxyl groups.

- (e) **acetate** — a manufactured fiber in which the fiber-forming substance is cellulose acetate. Where not less than 92% of the hydroxyl groups are acetylated, the term triacetate may be used as a generic description of the fiber.

- (f) **saran** — a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 80% by weight of vinylidene chloride units ($-\text{CH}_2-\text{CCl}_2-$).

- (g) **axlon** — a manufactured fiber in which the fiber-forming substance is composed of any regenerated naturally occurring proteins.

- (h) **nytril** — a manufactured fiber containing at least 85% of a long chain polymer of vinylidene dinitrile ($-\text{CH}_2-\text{C}(\text{CN})_2-$) where the vinylidene dinitrile content is no less than every other unit in the polymer chain.

- (i) **nylon** — a manufactured fiber in which the fiber-forming substance is any long chain synthetic polyamide having recurring amide groups ($-\text{C}-\text{NH}-$) as an integral part of the polymer



chain.

- (j) **rubber** — a manufactured fiber in which the fiber-forming substance is comprised of natural or synthetic rubber, including the following categories:

- (1) a manufactured fiber in which the fiber-forming substance is a hydrocarbon such as natural rubber, polyisoprene, polybutadiene, copolymers of dienes and hydrocarbons, or amorphous (non-crystalline) polyolefins.

- (2) a manufactured fiber in which the fiber-forming substance is a copolymer of acrylonitrile and a diene (such as butadiene) composed of not more than 50% but at least 10% by weight of acrylonitrile units ($-\text{CH}_2-\text{CH}-$). The term "lastrile" may be



used as a generic description for fibers falling within this category.

- (3) a manufactured fiber in which the fiber-forming substance is a polychloroprene or a copolymer of chloroprene in which at least 35% by weight of the fiber-forming substance is composed of chloroprene units ($-\text{CH}_2-\text{C}=\text{CH}-\text{CH}_2-$).



- (k) **spandex** — a manufactured fiber in which the fiber-forming substance is a long chain synthetic polymer comprised of at least 85% of a segmented polyurethane.

- (l) **vinol** — a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 50% by weight of vinyl alcohol units ($-\text{CH}_2-\text{CHOH}-$), and in which the total of the vinyl alcohol units and any one or more of the various acetal units is at least 85% by weight of the fiber.

- (m) **olefin** — a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of ethylene, propylene, or other olefin units, except amorphous (non-crystalline) polyolefins qualifying under category (1) of Paragraph (j) of Rule 7.

- (n) **vinylon** — a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of vinyl chloride units ($-\text{CH}_2-\text{CHCl}-$).

- (o) **metallic** — a manufactured fiber composed of metal, plastic-coated metal, metal-coated plastic, or a core completely covered by metal.

- (p) **glass** — a manufactured fiber in which the fiber-forming substance is glass.

Some Physical Properties of Man-Made Fibers

(Standard laboratory conditions for fiber tests: 70°F. and 65% relative humidity)

FIBER	BREAKING TENACITY ¹ (grams per denier) (standard) (wet)		SPECIFIC GRAVITY ²	STANDARD MOISTURE REGAIN ³ (%)	EFFECTS OF HEAT
CELLULOSIC FIBERS:					
acetate (filament and staple)	1.2 to 1.5	0.8 to 1.2	1.32	6.0	Sticks at 350 to 375° F. Softens at 400 to 445° F. Melts at 500° F. Burns relatively slowly.
rayon (filament and staple)					
regular tenacity	0.73 to 2.6	0.7 to 1.8	1.50 to 1.53	13	Does not melt. Decomposes at 350 to 464° F. Burns readily.
medium tenacity	2.4 to 3.2	1.2 to 1.9	1.50 to 1.53	13	
high tenacity	3.0 to 6.0	1.9 to 4.6	1.50 to 1.53	13	
high wet modulus	2.5 to 5.5	1.8 to 4.0	1.50 to 1.53	13	
triacetate (filament and staple)	1.2 to 1.4	0.8 to 1.0	1.3	3.2	Before heat treatment, sticks at 350 to 375° F. After treatment, above 464° F. Melts at 575° F.
NON-CELLULOSIC FIBERS:					
acrylic (filament and staple)	2.0 to 3.5	1.8 to 3.3	1.14 to 1.19	1.3 to 2.5	Sticks at 450 to 497° F., depending on type.
modacrylic (filament and staple)	2.0 to 3.5	2.0 to 3.5	1.30 to 1.37	.4 to 4	Will not support combustion. Shrinks at 250° F. Stiffens at temperatures over 300° F.
nylon					
nylon 66 (regular tenacity filament)	3.0 to 6.0	2.6 to 5.4	1.14	4.0 to 4.5	Sticks at 445° F. Melts at about 500° F. Same as above.
nylon 66 (high tenacity filament)	6.0 to 9.5	5.0 to 8.0	1.14	4.0 to 4.5	
nylon 66 (staple)	3.5 to 7.2	3.2 to 6.5	1.14	4.0 to 4.5	Same as above. Melts at 414 to 428° F. Melts at 414 to 428° F.
nylon 6 (filament)	6.0 to 9.5	5.0 to 8.0	1.14	4.5	
nylon 6 (staple)	2.5	2.0	1.14	4.5	
olefin (polypropylene) (filament and staple)	4.8 to 7.0	4.8 to 7.0	.91	—	Melts at 325 to 335° F.
polyester					
regular tenacity filament	4.0 to 5.0	4.0 to 5.0	1.22 or 1.38*	0.4 or 0.8*	Melts at 480 to 550° F. Melts at 480 to 550° F. Melts at 480 to 550° F. Melts at 480 to 550° F.
high tenacity filament	6.3 to 9.5	6.2 to 9.4	1.22 or 1.38*	0.4 or 0.8*	
regular tenacity staple	2.5 to 5.0	2.5 to 5.0	1.22 or 1.38*	0.4 or 0.8*	
high tenacity staple	5.0 to 6.5	5.0 to 6.4	1.22 or 1.38*	0.4 or 0.8*	
saran (filament)	up to 1.5	up to 1.5	1.70	—	Softens at 240 to 280° F. Self-extinguishing.
spandex (filament)	0.6 to 0.9	0.6 to 0.9	1.20 to 1.21	.75 to 1.3	Degrades slowly at temperatures over 300° F. Melts at 446 to 518° F.
vinyon (staple)	0.7 to 1.0	0.7 to 1.0	1.33 to 1.35	up to 0.5	Becomes tacky and shrinks at 150° F. Softens at 170° F. Melts at 260° F. Will not support combustion.

* Depending on type.

¹ BREAKING TENACITY: The stress at which a fiber breaks, expressed in terms of grams per denier.

² SPECIFIC GRAVITY: The ratio of the weight of a given volume of fiber to an equal volume of water.

³ STANDARD MOISTURE REGAIN: The moisture regain of a fiber (expressed as a percentage of the moisture-free weight) at 70° F. and 65% relative humidity.

NOTE: Data given in ranges may fluctuate according to introduction of fiber modifications or additions and deletions of fiber types.

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